AGRICULTURAL ENGINEERING

Published by the American Society of Agricultural Engineers, Saint Joseph, Michigan

Publication Office, Bridgman, Michigan. Editorial and Advertising Departments, Saint Joseph, Michigan

LEONARD J. FLETCHER, President — RAYMOND OLNEY, Secretary-Treasurer

Volume 13 — FEBRUARY, 1932 — Number 2

CONTENTS

Subscription price to non-members of the Society, $3.00 a year, 30 cents a copy; to members of the Society, $2.00 a year. Postage to countries to which second-class rates do not apply, $1.00 additional. Entered as second-class matter, October 8, 1925, at the post office at Bridgman, Mich., under the Act of August 24, 1912. Additional entry at St. Joseph, Mich. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized August 11, 1921. The title Agricultural Engineering is registered in the U. S. Patent Office.

AGRICULTURAL ENGINEERING

Volume 13 FEBRUARY, 1932 Number 2

George Washington—America's First Agricultural Engineer

By M.A.R. Kelley[1]

THE MORNING SUN passes through the apse of the Washington National Cathedral as it enters my bedroom window. I gaze upon Wisconsin Avenue, a road famous since the days of Indian trails. It was an important military road during the French and Indian, Revolutionary, and Civil wars. It is the national highway of the present road system and one of the many entrances with which Washington is favored. It is especially interesting, scenically as well as historically. It is the trail taken by General Braddock and his army on April 20, 1775, on the way to Fort Duquesne to defend the frontiers against the French and Indians.

It was at the place now known as Braddock Heights that on July 9 the disastrous engagement occurred in which the general was wounded, and died four days later. It is here that we introduce young George Washington, an aide to General Braddock who took command in his first big military engagement.

It has been my privilege and pleasure to visit many of the shrines of American history which have been associated with George Washington. Visit the beautiful Valley Forge and recall the famous winter of 1777-78, follow Washington's trail through Chadds Ford, Trenton, Princeton, and White Plains, and study your American history first hand. The military life of Washington is well known, and we need not recall it at this time.

The old saying is "First in war, first in peace, and first in the hearts of his countrymen." I wish now to nominate him for one other premier place—America's first agricultural engineer. I like to think of an agricultural engineer as one whose training and knowledge of fundamental engineering is used for the improvement and advancement of agriculture in the field and in the farm home.

That Washington was an engineer is shown by his commission as public surveyor granted by King William's and Queen Mary's College in Williamsburg, Virginia, on July 20, 1749, the second oldest college in the United States. He received much of his training from Lord Fairfax who employed him to survey a large tract of land.

Fig. 1 shows the house on the old Ferry Farm where he spent most of his boyhood days from 1739 to 1747. This little one-story structure was used by the youthful Washington as a work room. Doubtlessly it is here that he learned his ABCs in engineering. This structure is the only one now in existence which is positively known to have been used by him during his boyhood. While living at this farm he attended school at Falmouth and Fredericksburg, a nearby village across the river, two miles below the falls on the Rappahannock River. To this farm is attached the famous story of the mythical cherry tree.

The cherry tree shown in Fig. 2 is just behind the house shown in Fig. 1. It is shown to the visitors as a granddaughter of the famous tree. It was destroyed by a wind storm in August, 1930. Recent studies reveal that the first cherry tree was planted on this farm 60 years after Washington had left.

He went to Mount Vernon after his father's death and made his home there whenever the affairs of state would permit, until his death. At the time of his death, Washington owned more than 60,000 acres. This included property in Maryland, Pennsylvania, New York, Kentucky, Ohio, and Virginia. In his will he estimated the value of this land from $1.00 to $20.00 per acre, with an average of $10.00.

Mount Vernon was made up of what was known as the Mansion House Farm, Union Farm, Dogue Run Farm, Muddy Hole Farm and River Farm, consisting of 8,000 acres in all. Washington regarded Dogue Run as much the best. It is here that he built the famous sixteen-sided circular barn. This marks the first introduction of this architectural monstrosity, and which in recent decades has been used in the central states. Washington said that if this barn proved successful, he would build another. History does not tell us that he ever built the second one.

Washington conducted at Mount Vernon our first real agricultural experiment station. He was always importing seeds from other countries and first introduced lucern, a plant now commonly known as alfalfa. He studied rotations and found endless interest

[1]Agricultural engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture, Washington, D. C. Mem. A.S.A.E.

Fig. 1. (Left) George Washington's first engineering office on the Ferry Farm, Fredericksburg, Virginia. It is the only structure now in existence which is positively identified with Washington's boyhood. Fig. 2. (Middle) Granddaughter of the mythical cherry tree on the Old Washington Farm; it was destroyed by a wind storm in 1930. Fig. 3. (Right) This was Washington's office while building the Chesapeake and Ohio Canal, and is located on M Street in Washington, D. C.

Fig. 4. (Left) This was Washington's headquarters while building Fort Louden at Winchester, Virginia, one of his early engineering activities. Fig. 5. (Right) A Revolutionary War cannon in the foreground. Fort Louden was located on the back of this lot

in trying to improve the fertility and most adaptable crops. Washington believed that his land was not fitted for the maintenance of an improved type of cattle. The fact remains that Mount Vernon herds and stocks were never noted for any particular excellence.

One particular point of interest to agricultural engineers, in Washington's practice of animal husbandry, is his introduction of the long-eared variety of farm power. After he had put aside his sword, he wrote a letter to the American ambassador to the court of Spain "to procure permission to extract a jackass of the best breed." But the exportation of these animals was at that time forbidden, and it is only because of the king's great regard for Washington as a soldier that he was allowed two jacks and a pair of jennets. One of the jacks died enroute, and the others reached Mount Vernon in December, 1785. The surviving jackass was named "Royal Gift," the first of his kind in North America. Royal Gift did not do well as a breeder, and a second importation was secured from the Island of Malta through the help of General Lafayette. The second jack was named the Knight of Malta and proved a brilliant success. Thus to Washington we owe the introduction of one source of farm power.

Many new farm implements were imported from England, and new ones devised by Washington for use at Mount Vernon. We find him improving machines for drilling wheat and corn, gathering clover seed and raking up wheat.

He records in his diary on April 8, 1786: "Rid a little after sunrise to Muddy Hole to try my drill plow again which, with the alterations of the harrow yesterday, I find will fully answer my expectations, and that it drops the grains, thicker or thinner in proportion to the quantity of seed in the Barrel. The less there is in it the faster it issues from the holes. The weight of the quantity in the barrel, occasions (I presume) a pressure on the holes that does not admit of a free discharge of the seed through them, whereas a small quantity (sufficient at all times to cover the bottom of the barrel) is in a manner sifted through them by the revolutions of the Barrel."

He was the first to advocate the use of soil-erosion dams, and was an advocate of farm drainage. He improved the building of farm fences and farm buildings. As vestry man of Truro Parish he made the plans, surveyed the land, and personally superintended the building of the historic structure, Pohick Church. This structure was used as a stable by a troop of Union soldiers during the Civil War. Thus we learn that Washington was active in improving farm crops, farm power, drainage, farm structures, and inventing farm machinery.

The most notable of Washington's engineering achievements were the survey and building of the Potomack Canal, and later the canal through the Dismal Swamp of Virginia The Potomack Canal was the first engineering works of its kind in America.

The American Engineering Council proposes to spend $150,000 in restoring a portion of the old locks and canal which still exist at Great Falls and build a model showing its operation. This model will portray the entire canal, with the surrounding topography, rock outcrop and old structures. It will be equipped with locks and will have a supply of water for its operation.

Potomac Gorge, Great Falls, about 12 miles west of the Capital is among the loveliest and most beautiful spots to be found around Washington. When the flood waters of the spring come leaping down the rocky gorge, it presents a picture which is excelled by but few of the falls of America.

Great Falls is closely associated with the name of George Washington as an engineer. For there lies, in what is now a public amusement park, the ruins of an old mill and an iron foundry which owed their existence to the Potomack Canal.

In 1784 Washington explored in person the route for a waterway up the Potomac and as far west as Pittsburg, making a complete detailed report.

The Potomack Company was incorporated during the same year and continued until 1830, when it sold out to the Chesapeake and Ohio Canal Company.

The locks at Great Falls were completed in 1802 and were in operation as late as 1924, during which year they were closed for the last time because of a spring flood which caused serious damage to the canal properties.

Over the placid water of the canal passed many million tons of freight consisting of coal, grain, hay, stone and lumber. It was used extensively during the late World War to carry coal from Cumberland, the western terminus, to Washington.

The house shown in Fig. 3 was used by Washington as a headquarters while building the canal.

The layout for the proposed engineering memorial will contain several acres and the working model will serve to remind all those who visit the beautiful Great Falls that Washington was an engineer.

Mount Vernon Buildings[1]

HE (WASHINGTON) added building after building to the home group until there was a total of thirty smaller structures on two sides of the mansion, each located so as to promote efficiency and promptness of service as well as ease in supervising the work. There was the kitchen, close to the main house and connected with it by an arcade. There were the storehouse, smokehouse, wash-house, salt-house, spinning house (in which sixteen wheels were operated), greenhouse, spring house, hospital for ill servants, milk house, butler's house, servants' quarters, gardener's house, and (a rare luxury in those days) an ice-house which Washington always had filled with snow when the winters were too mild to harvest ice.

[1]From "The Washingtons at Home" in the "Journal of Home Economics" Vol. 24, No. 2 (February 1932).

Characteristics of Feed Mill Performance[1]

By E. A. Silver[2]

IN THE preparation of food for animals it is desirable to know the processes by which food is converted into useful work. The first of these is digestion, which is generally defined as the changes which take place within the digestive system of the animal, in separating the useful portion of the food from the waste matter, for body absorption. Digestion is followed by metabolism, a process by which the digestible nutrients are converted and absorbed into the living matter of the body. This may be for the production of work, meat or milk. A nutrient may be one or any group of food constituents. Digestible nutrients are the parts of food which are digested and taken into the body.

Food, therefore, passes through numerous chemical changes before it is finally absorbed by the living matter of the body. With most animals the first step in digestion usually occurs in the mouth by the process of mastication. As the food is ground between the teeth of the animal it becomes thoroughly mixed with saliva. The digestive fluids cannot reach and attack some feeds thoroughly unless they are broken up to expose the nutrients within. Feeds such as grains, with impervious coating resist the action of the digestive fluids and must be broken up before any digestion can take place.

Grinding or crushing grain, therefore, aids (1) digestion, (2) mastication, for animals with poor teeth, (3) consumption of more feed per unit of time, and (4) elimination of waste of feed.

Grinding grain is especially desirable for young animals, before they have their permanent teeth; and for mature animals, with teeth which have become ineffective for mastication purposes. Generally more feed can be consumed per unit of time if it is ground. This is especially desirable toward the end of a fattening period, in order to put on gains rapidly and produce a well-finished animal. The hard-working dairy cow is helped by some preparation of her feed to maintain heavy milk production. In addition, the grinding of some feeds may increase their palatability, an important factor in stimulating digestion and an inducement for the animal to consume heavy rations.

A considerable number of feeds, mostly roughage, can be ground so that all of the feed may be consumed. Most animal husbandry men tell us, however, that it does not pay to grind roughages due to the small percentage of digestible nutrients present. However, for maintaining mature animals, which generally require little protein but a large amount of energy-building material, it sometimes may pay to grind these materials.

MACHINES FOR GRINDING PURPOSES

Feed is by far the largest single cost item in livestock production. It ranges from 50 to 80 per cent of the total cost, depending of course upon the type and class of livestock fed, their management, care, and feeding practices followed. The grinding of feed may be considered as an added expense to feed costs, therefore the economic phase of grinding should be stressed to the fullest extent.

There are three general types of feed mills—burr, hammer, and combination—used to grind feeds on the farm. The burr mill is so termed because of the principle of using corrugated plates or burrs between which material is ground. One burr, which revolves, is fastened to one end of the main drive shaft. The other is held to the body of the mill and does not revolve. Burr mills are not generally adaptable to the grinding of roughages or materials with a high fiber content. In order to grind these particular materials, it is necessary to set the burrs close, to produce a good shearing action. Friction between the burrs is increased and the efficiency of grinding lowered to a great extent.

Hammer mills, which have become very popular within the last few years, employ hammers for reduction purposes. These hammers generally revolve at high speeds, breaking and beating up the material in the grinding or hammer chamber. Somewhere close to the periphery of the circle in which the hammers revolve is located a screen, through which the pulverized material passes. It is then elevated by a fan to the bin or sack.

Hammer mills are of two general types with hammers either swinging or rigid. The swinging hammer is hinged and free to swing through an off-center arc. The rigid hammer has no hinging feature and is usually fastened to the rotor shaft by means of jam nuts. These two types of hammers have their advantages and disadvantages, and as

[1]Paper presented at a meeting of the Power and Machinery Division of the American Society of Agricultural Engineers, at Chicago, December 1931.

[2]Research agricultural engineer, Ohio State University. Mem. A.S.A.E.

FIG. 2. ANALYSIS OF PARTICLE SIZES OF A GROUND SAMPLE AT HIGH AND LOW SPEEDS

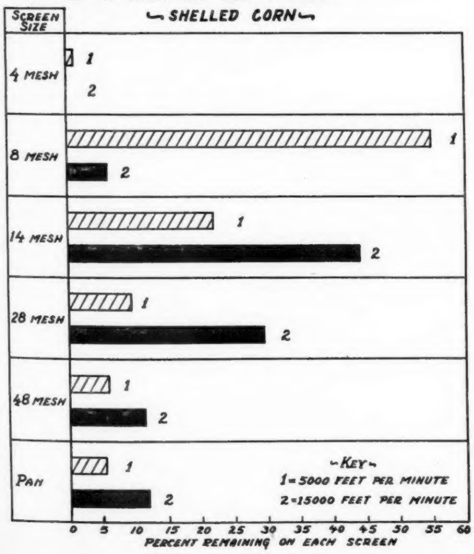
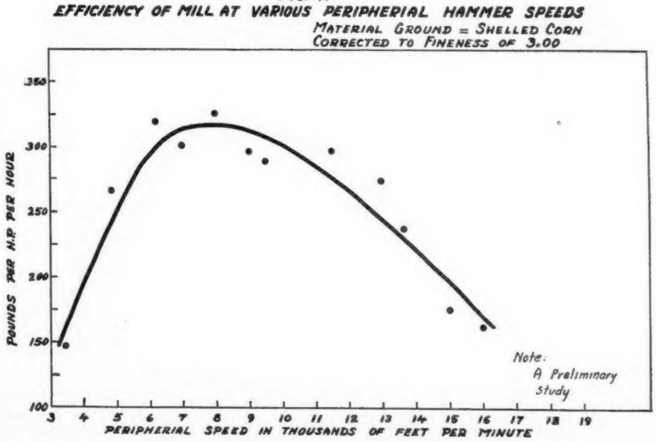


FIG. 4. EFFICIENCY OF MILL AT VARIOUS PERIPHERIAL HAMMER SPEEDS



yet insufficient experimental work has been done to indicate the most efficient type for all grinding.

Combination mills may employ either burrs or hammers for final reduction purposes, but in addition they contain some form of cutter head. This construction is especially desirable for roughage grinding, inasmuch as this material can be reduced in size more economically and efficiently by the cutting process than by other means. In addition, this type of mill is very adaptable where the mixing of grains with roughage is practiced.

QUALITY OF THE GROUND PRODUCT

In order that the animal may receive full value from the feed it consumes, it is necessary that the feed be converted into such form that the greatest degree of digestibility is obtained. The feed, therefore, must be in a palatable condition and in such form that thorough mastication takes place to aid in the digestion process. Hard carbohydrate materials, if fed whole, will pass through the animal undigested. If this material is finely pulverized there is a tendency for the animal to bolt it down without chewing. The ground particles should be as nearly uniform in size as possible and, for the majority of livestock, fairly coarse or large, in order that the starch of the material may be exposed and changed to malt sugar during the process of mastication.

Finely ground material also constitutes a waste, both in feed and power consumption, because there is a tendency for livestock to leave it in the feed trough. Of course this waste can sometimes be eliminated if the feed is mixed and fed with ground roughage.

From tests made, there seems to be a lack of uniformity of size of ground particles particularly on some grains such as shelled corn. This condition exists regardless of the type of mill used. Fig. 1 gives analysis of the size of the particles in ground samples taken from burr and hammer mills. These fineness samples were screened through screens of various meshes per inch as recommended by the American Society of Agricultural Engineers for fineness tests. The percentage of a 250-grain sample which remained on each screen is shown by the bars of the chart. In addition to what remained on the 100-mesh sieve, there was always a small amount on the pan beneath, which varied from one to five per cent.

An ideal sample and ground at the fineness of 3.00 would be retained on the third screen from the bottom, or the 28-mesh sieve. As will be seen from the chart, it is plainly evident that there is a great lack of uniformity of size of particles and certainly too much finely powdered material produced. In the case of hammer mills the high speed is in no small measure responsible for this condition, as Fig. 2 will indicate. Running the mill at a peripheral speed of 5,000 feet per minute produces much more uniform grinding than when it is running at 15,000 feet per minute.

FINENESS OF GRINDING

The standard method for determining the fineness of the ground material is the modulus or index system adopted by the American Society of Agricultural Engineers. The small numbers represents fine grinding and the larger numbers coarser grinding. A fine sample with the consistency of corn meal would have a fineness of approximately 2.00. Cracked corn would have a fineness of approximately 4.80 to 5.00.

Considerable difference of opinion exists among commercial feed men and farmers relative to what constitutes coarse, medium, or fine grinding. One man's idea of medium grinding may be another man's idea of coarse grinding. At the present time the moduli of fineness seems to be the only accurate method for determining the fineness of grinding.

In order to give some general idea of what constitutes coarse, medium, fine, and very fine grinding, the Ohio Agricultural Experiment Station has prepared a chart showing these various grades of fineness on the most common grains and roughages. The common terms: "Coarse," "medium," etc., are used along with the moduli of fineness. (See Table I.)

This classification is based largely upon the size and nature of the whole product. For instance, whole shelled corn has a modulus of 6.00. On coarse grinding of this product the modulus of fineness is 4.80. Whole oats has a modulus of 4.50 which is below that of coarsely ground corn. Coarse grinding of oats was, therefore, classified at 3.70. Whole grains of course will vary in size, depending upon the section of the country in which they were grown, but probably not to an extent that would justify a change in the moduli of fineness for the various grades of fineness. Corn stover and corn fodder were given a coarser grade of fineness than most of the other roughages. This was because the material is bulkier, and animal husbandry men seem disposed to recommend very coarse grinding of these products, if grinding is recommended at all.

At the present time the most desirable fineness of grinding feeds is a debatable question. It does not seem that feeding coarsely ground grain or roughage would be best in one section of the country and medium ground

TABLE I. Classification of Moduli of Fineness for Various Finenesses of Grinding on the Common Grains and Roughages

	Whole grain	Coarse grinding	Medium grinding	Fine grinding	Very fine grinding
Grains					
Ear corn	....	4.80 (5.40—4.20)	3.60 (4.20—3.00)	2.40 (3.00—2.10)	1.80 (2.10—1.50)
Shelled corn	6.00	4.80 (5.40—4.20)	3.60 (4.20—3.00)	2.40 (3.00—2.10)	1.80 (2.10—1.50)
Barley	5.00	4.10 (4.50—3.60)	3.20 (3.60—2.70)	2.30 (2.70—1.90)	1.50 (1.90—1.30)
Oats	4.50	3.70 (4.10—3.30)	2.90 (3.30—2.50)	2.10 (2.50—1.70)	1.40 (1.70—1.20)
Soybeans	6.00	4.80 (5.40—4.20)	3.60 (4.20—3.00)	2.40 (3.00—2.10)	1.80 (2.10—1.50)
Wheat	5.00	4.10 (4.50—3.60)	3.20 (3.60—2.70)	2.30 (2.70—1.90)	1.50 (1.90—1.30)
Roughages					
Corn stover	....	5.50 (6.00—4.80)	4.20 (4.80—3.50)	2.90 (3.50—2.20)	....
Corn fodder	....	5.50 (6.00—4.80)	4.20 (4.80—3.50)	2.90 (3.50—2.20)	....
Soybean hay	....	4.00 (4.50—3.50)	3.10 (3.50—2.60)	2.20 (2.60—1.80)	1.40 (1.80—1.30)
Alfalfa hay	....	4.00 (4.50—3.50)	3.10 (3.50—2.60)	2.20 (2.60—1.80)	1.40 (1.80—1.30)
Clover hay	....	4.00 (4.50—3.50)	3.10 (3.50—2.60)	2.20 (2.60—1.80)	1.40 (1.80—1.30)

NOTE: Corn Stover—No ears of corn attached. Corn Fodder—Ears of corn attached. Upper and lower limits for fineness in parentheses.

TABLE II. Fineness of Grinding for All Classes of Livestock, as Recommended by the Animal Husbandry and Poultry Departments

Feeds	Fineness of grinding	Beef cattle	Dairy cattle	Dairy calves	Swine	Sheep	Lambs up to 8 wks. of age	Horses		Chicks	Hens	
								Wet mix	Dry		Scratch	Mash
Shelled corn	Grade	Med.-coarse	Medium	Med.-coarse	Whole	Whole	Med.-coarse	*	†Whole or very coarse	Fine-medium	Med.-coarse	Med.-fine
	Modulus	4.20	3.60	4.20			4.20		5.00	2.80	4.20	2.80
Ear corn	Grade	Med.-coarse	Medium	Med.-coarse	Whole	*	*	*	Whole	*	*	*
	Modulus	4.20	3.60	4.20								
Oats	Grade	Med.-coarse	Medium	Medium	Medium	Whole or very coarse	Whole or very coarse	Med.-coarse	Rolled	Fine	Whole	Fine
	Modulus	3.20	2.90	2.90	2.90	4.00	4.00	3.20		2.10	4.50	2.10
Barley	Grade	Very coarse	Med.-coarse	Fine-medium	Fine-medium	Fine-medium	Fine-medium	Med.-coarse	Rolled	Very fine	Whole	Very fine
	Modulus	4.50	3.60	2.90	2.90	3.00	3.00	3.60		1.50	5.00	1.50
Soybeans	Grade	Whole	Fine-medium	Coarse	Very fine	Very coarse	Very coarse	*	†Very coarse	Fine	*	Fine
	Modulus	6.00	3.10	4.80	1.80	5.00	5.00		5.00	2.40		2.40
Wheat	Grade	Coarse	Medium	Coarse	Medium	Very coarse	Very coarse	*	†Rolled	Fine	Whole	Med.-coarse
	Modulus	4.10	3.20	4.10	3.20	4.30	4.30			2.30	5.00	3.50
Rye	Grade	Coarse	Medium	Coarse	Medium	Very coarse	Very coarse	*	†Rolled	*	*	*
	Modulus	3.70	2.90	3.70	2.90	3.90	3.90					
Alfalfa	Grade	Whole	Whole and fine for mixtures	Coarse	Very fine-fine	Whole and fine for mixture	Whole	Chopped	*	Very fine	Very coarse	Very fine
	Modulus		2.20	4.00	1.40	2.20				1.40	6.00	1.40
Soybean hay	Grade	Whole or very coarse	Whole or coarse	Whole or coarse	Medium	Whole	Whole	Chopped	Whole	Very fine	Very coarse	Very fine
	Modulus	5.00	4.00	4.00	3.10					1.40	5.00	1.40
Clover hay	Grade	Whole	Whole	Whole	Medium	Whole	Whole	Chopped	Whole	Very fine	Very coarse	Very fine
	Modulus				3.10					1.40	5.00	1.40
Corn fodder	Grade	Shredded	*	*	*	*	*	*	*	*	*	*
	Modulus	6.00										
Corn stover	Grade	Whole	Whole	Whole	*	Whole	Whole	*	Whole or shredded	*	*	*
	Modulus								6.00			

*Not recommended. †Seldom fed.
NOTE: Contributed by Animal Husbandry and Poultry Departments, Ohio State University.

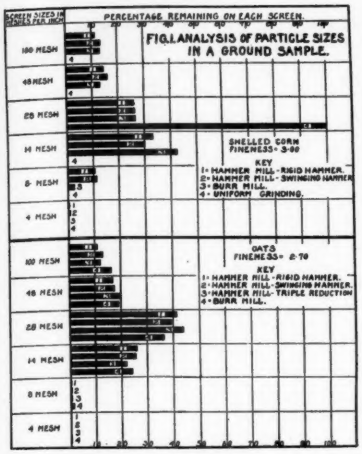


FIG. 1. ANALYSIS OF PARTICLE SIZES IN A GROUND SAMPLE.

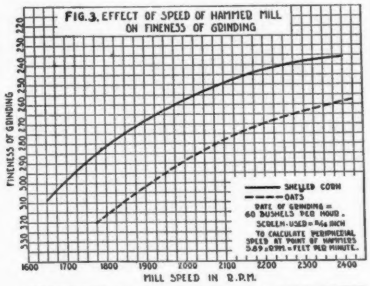


FIG. 3. EFFECT OF SPEED OF HAMMER MILL ON FINENESS OF GRINDING

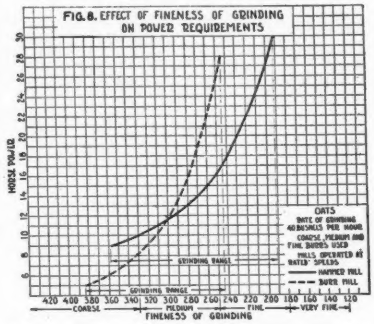


FIG. 8. EFFECT OF FINENESS OF GRINDING ON POWER REQUIREMENTS

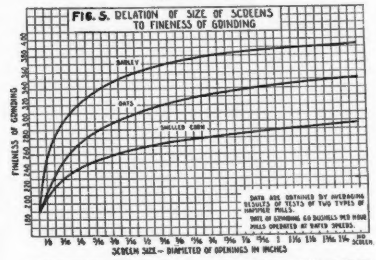


FIG. 5. RELATION OF SIZE OF SCREENS TO FINENESS OF GRINDING

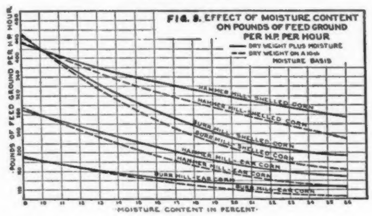


FIG. 9. EFFECT OF MOISTURE CONTENT ON POUNDS OF FEED GROUND PER H.P. PER HOUR

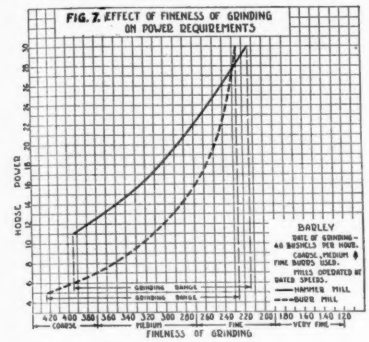


FIG. 7. EFFECT OF FINENESS OF GRINDING ON POWER REQUIREMENTS

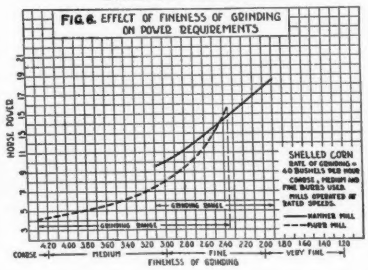


FIG. 6. EFFECT OF FINENESS OF GRINDING ON POWER REQUIREMENTS

material more desirable in another section. Yet there is very little data on the subject upon which all authorities agree. This is one phase of work which calls for immediate standardization. As long as this condition exists a great handicap is put upon the designer of feed mills as well as the livestock feeder who handles the ground material.

There is a tendency at the present time for animal husbandry and poultry men to recommend rather coarse grinding. This, of course, depends upon the class of livestock fed, the kind of grain ground, and the ultimate purpose of the animal's feed. Usually, coarse grinding is recommended for grains high in starch, while for those high in fiber, a medium to fine grade is recommended. Coarse grinding will naturally lessen the wear and tear on the mill, increase its capacity and decrease the horsepower required. Therefore, it costs much less than fine grinding. In addition, animals with good teeth will generally masticate and digest coarsely ground materials more completely than the finely ground materials.

In order to arrive at some standard for the fineness of grinding grains and roughages, the animal husbandry and poultry departments of Ohio State University have made some recommendations. Until further experimental work has been done along this line, these recommendations will probably serve to give a general idea in regard to the degree of fineness of grinding of feeds. (See Table II.)

A study of these recommendations indicates that in most cases coarse grinding is favored over fine grinding. For beef cattle coarse grinding is generally recommended, while for dairy cattle a little finer grade is more desirable. Sheep require very little grinding of their feed, but in the event that grinding is done it should be coarse. Swine and poultry require both coarse and fine grinding, in different methods of feeding. Very little grinding of roughages is recommended except for mixtures where fine grinding is usually desirable.

Burr mills, generally, have little trouble in grinding coarsely. Hammer mills, however, have a tendency to grind too finely, especially on starchy grains such as shelled corn. This is in no small measure due to the high peripheral speeds at which hammer mills are operated. A low peripheral speed will produce coarse grinding while a high peripheral speed will produce fine grinding (Fig. 3).

Results of tests completed by the Ohio Agricultural Experiment Station, and other stations as well, indicate that hammer mills operated at their rated speeds will grind shelled corn to a fineness near or below 3.20, even with no screen installed. This, according to the classification, is between a fine to medium grade, which in many cases does not meet the recommendations of animal husbandry men. In order to secure coarser grinding of shelled corn it is necessary either to slow down the speed of the mill or to decrease the number of hammers. If the speed of the mill is decreased below the manufacturer's rating to any great extent, trouble is sure to be had in elevation, due to a corresponding decrease in the speed of the fan. With the elimination of some of the hammers, uniformity of size of ground particles is effected.

Not only do the high peripheral speeds of hammer mills make coarse grinding impossible; a few preliminary tests show that the present speeds of 14,000 to 15,000 feet per minute are much above the most critical or economical point. There is no question but what the capacity of a mill is increased with the speed, at least up to the point of approximately 15,000 feet per minute. Fig 4 indicates that the most efficient peripheral speed is between 7,000 and 9,000 feet per minute. Mills show more efficient operation at these speeds, and in addition, do more uniform and coarser grinding.

These tests were run with the exhaust fan detached from the mill and operated by a separate power unit. The rate of feeding was set at 50 bushels per hour.

If further investigation proves that these rates of speed are the most efficient, then capacity may be figured as a function of width of screen rather than of speed, as seems to be the case at the present time. Incidentally, this may lead to a simple method by which to rate hammer mills.

The grain receives its first reduction in size by the impact from the hammers as it enters the grinding chamber. It is then thrown with terrific force against the screen or other parts of the mill. Some of the broken grain particles may be driven through the screen. Others, regardless of their size, may strike a solid part of the screen and bounce back in the face of the rapidly revolving ham-

mers. This process may continue until the particles are reduced to meal or very finely pulverized material. The suction from the fan will finally draw this fine material through the holes of the screen. This action of course would be more pronounced on the hard starchy grains. If the hammers revolve more slowly, the material will have a better chance to settle through the screen, eliminating some of the unnecessary pounding which the grain receives at high speeds.

On grinding shelled corn (Fig. 5), with no screen installed in the mills, the fineness of grinding was not much above a modulus of 3.00. From a 1¼-inch screen down to a ½-inch screen there was very little difference in fineness of grinding. From the ½-inch screen down to the 1/16-inch or 3/32-inch screen the curve drops rapidly, indicating that the fineness of grinding varies over greater increments between the finer screen sizes.

Under these conditions, and with a large assortment of screen sizes available, it is rather difficult for the farmer to determine what screens to use for the many materials he usually grinds. It will be seen from Table III that, on barley or oats grinding, very close to the same size of screen will suffice in most cases to produce the same grade of fineness. On shelled corn, however, a 1¼-inch screen, which is about the largest size stocked by manufacturers, will only produce a grade of fineness from fine to medium. This is, in most cases, much too fine, especially for the class of livestock which depends upon shelled corn for the greater part of its ration.

FEED MILL EFFICIENCY

Efficiency in feed mill operation depends upon the kind and nature of the materials ground, type of mill and equipment used, fineness of grinding and operation of the mill. Materials high in starch content are usually easy to grind while those high in fiber, oil, or water content are usually hard to grind. With the varying composition of grains and roughage one mill may be more adaptable to one kind of feed than it is to another. It may have a high capacity on some feeds and a low capacity on others. In addition, one type of mill may be adaptable to fine grinding and not to coarse grinding, or vice-versa.

On shelled corn grinding, (Fig. 6) the burr mill requires less horsepower and is more efficient than the hammer mill at a grade of fineness from coarse down to a modulus of approximately 2.40. Below a modulus of 2.40 the curves show that the hammer mill requires less horsepower than the burr mill. The curves further show that the burr mill will grind over a greater and coarser range than that of the hammer mill.

On barley grinding (Fig. 7) the results are similar to those on shelled corn, with the burr mill again showing greater efficiency on the coarse grinding and the hammer mill on the fine grinding. The curves rise a little more abruptly than was the case of those on shelled corn, especially toward finer grinding. This indicates that the ratio of horsepower to fineness is slightly greater than that on shelled corn grinding, undoubtedly due to the slightly higher fiber content of barley. The grinding range for the hammer mill is increased to about equal that of the burr mill in capacity for coarse grinding.

Entirely different results are obtained in oats grinding from those on shelled corn or barley. The grain has a higher fiber content, which works to the disadvantage of burr mills. This was indicated by the extremely high temperatures of the material after grinding. The increase in temperature of the ground material over the unground material for the burr mill varied from 25 to 74 degrees (Fahrenheit), with a maximum temperature of 147 degrees. For the hammer mill the increase in temperature varied from 4 to 23 degrees. Increase in temperature of the materials was influenced by the rate of feeding. Both mills in these tests were grinding at a fineness modulus of 2.70.

On this grain (Fig. 8)) the hammer mill shows much higher efficiency than that shown on the previous tests, except for a very short range on coarse grinding. The curves rise much more abruptly, indicating that the horse-

TABLE III, Approximate Size of Screens for Various Finenesses of Grinding

Grades of fineness of grinding	Shelled corn	Barley	Oats
	Inch	*Inch*	*Inch*
Coarse	*	1 1/4	1 1/4 to no screen
Medium to coarse	*	1/2	3/4
Medium	*	1/4	5/16
Fine to medium	1 1/4	3/16	3/16
Fine	1/4	1/8	1/8
Very fine to fine	1/8	3/32	3/32
Very fine	3/32	1/16	1/16

*Mills on test could not produce grade of fineness even with no screen installed.

power increases rapidly as the fineness increases. This is undoubtedly due to the high fiber content of oats. The grinding range for the hammer mill is greater than that of the burr mill, the reverse of condition for shelled corn and barley.

Throughout all of these tests full sets of burrs were used on burr mills and screens from 1/16-inch up to 1¼-inch on the hammer mills. The moisture content of the oats was 10 per cent; barley, 14 per cent; and shelled corn, 12 per cent. The rate of grinding was 40 bushels per hour in each case.

Mills will usually show the highest efficiency when working at full capacity or very close to it. However, as soon as the fan begins to lag or becomes overloaded, the efficiency of the mill is lowered quickly. Uniform, steady feeding is also an aid to higher efficiency. On many hammer mills it is practically impossible to grind roughages without "slugging" taking place. Feed rollers or self feeders, equipped with volume or speed governors seem to help in eliminating this trouble.

Grains and roughages with high moisture content are usually hard to grind (Fig. 9). On grains such as shelled corn, with high moisture content the hammer mill seems to show higher efficiency than the burr mill. However, on fibrous feeds which are high in moisture the screens of the hammer mill have a tendency to clog, which greatly lowers the efficiency. In the case of ear corn, moisture in the grain seems to have a greater effect in increasing the power requirement than the moisture which is present in the cob.

These tests, therefore, seem to indicate that the burr mill is adaptable to coarse grinding, while the hammer mill surpasses the burr mill for fine grinding. For grinding grains with a high starch content the burr type seems to excel the hammer type providing the grain is not too high in moisture content. For grinding grains with a high fiber content the hammer mill shows greater efficiency.

Without question, a great deal of standardization work could be done on hammer mills. Before much of this work can be accomplished it seems that the American Society of Agricultural Engineers should formulate some program for carrying it on. With proper coordination some very valuable contributions could be made, not only for the benefit of the manufacturer but the farmer as well.

Hammer Mill Rating Requirements[1]

THE OBJECTIVE of this committee is to form some satisfactory method for the rating of hammer mills—one that should be as nearly "fool-proof" as possible. This is by no means an easy task due to many variables which must be taken into consideration and also due to the lack of standardization on many points of feed mill design and operation.

The first requirement for the rating of hammer mills is that the rating adopted should be simple, brief, and concise. It should offer no 'loopholes" 'through which the indiscreet manufacturer may escape.

In the second place, regardless of what method is adopted, there are many variables to be taken into consideration such as moisture content of grain, kind of grain, fineness of grinding, peripheral speed of hammers, shape of hole in screen, size of screen, horsepower and capacity.

[1]From discussion outline of the A.S.A.E. Committee on Feed Mill Rating.

A German "Combine" Development

By H. H. Stippler[1]

IN NO OTHER COUNTRY has the mechanization of agriculture made such decided progress in the last decades as in the United States. This may be attributed not only to favorable natural conditions in most branches of agriculture and to the wealth of the farmers previous to the present depression, but mainly to the capacities of American agricultural engineers. These agricultural engineers have kept pace with the farmers by designing mechanical equipment suitable to the needs as they developed.

In other countries the natural and economic conditions during the last two decades have been less favorable. In many countries the use of labor-saving machinery is economically impracticable because the ordinary farm is too small for machinery of the present size. The use of small machines, on the other hand, is economically not so advantageous because the cost of construction in most cases cannot be lessened proportionately.

Other countries, particularly Germany, have tried to profit by American methods in agriculture though conditions are quite different. A special effort has been made in the case of harvesting grain mechanically. In 1927 the first "combine" (Case) was purchased privately and during the year 1928 seven combines were already in use. All of these were subjected to official investigation[2] in order to determine their suitability to German conditions. The following years, especially 1930 with its wet autumn, indicated that the imported American machines were not wholly adapted to German needs and that the investment was too great for the farm of average size.

A combine better suited to Central European conditions has recently been produced by a German manufacturing firm[3]. This seems to have proved satisfactory in experiments conducted during the last harvest[4]. Its construction is of importance not only to Europe but also to certain districts in the eastern part of the United States where farms compare in size and climatic conditions to those of central Europe.

The outstanding feature of the new German combine is that two separately working machines, a binder and a thresher, can be operated in one unit, as a harvester-thresher. The separator is placed between cutter bar and binder head. The cylinder of the separator lies lengthwise and is so arranged that the cut grain is elevated from the platform to the cylinder, threshed and the straw bound on the opposite side of the separator by the binding device of the binder. (See accompanying drawing.) The cylinder has rubbing bars instead of bars with teeth. Its diameter is 20 inches and its length 71 inches. Around the cylinder is a specially designed grate which in a stationary separator threshes with about 99 per cent efficiency and in the combine with only 2½ to 3 per cent loss of grain, compared to 5 per cent to 8 per cent with the harvest methods hitherto employed. Because of its efficiency in threshing the new machine has, instead of the usual long straw rack, a shorter one leading to the binding attachment. The straw is bound in bundles of 13 to 16 pounds. The grain only goes through a single cleaning operation at this time, because under German conditions it is hard to separate the grain from the small weed particles which when green have about the same size and specific weight as the grain itself. Under German climatic conditions it is necessary with the new machine, as well as with the old types, to clean the grain after the green weeds are dry. In using the separator as a stationary threshing machine, a second cleaning device might easily be attached. In combining, the grain is sacked from a tank, which allows it to be unloaded wherever desired. The chaff is blown by the cleaning blast into a filtering sack to make it dust free.

The separator is supported by two large wheels on a central axis and by one small auxiliary rear wheel. The binder has the usual large and small wheel. To move the combine along the road from one field to another, the binder, which is easy to detach, is placed behind the separator.

The separator is driven by a 15 to 20-horsepower motor, or by the pulling tractor by means of a power take-off. The sickle and elevating canvasses of the binder are operated by the main wheel as usual, but the binding attachment is driven by the motor of the separator or of the pulling tractor.

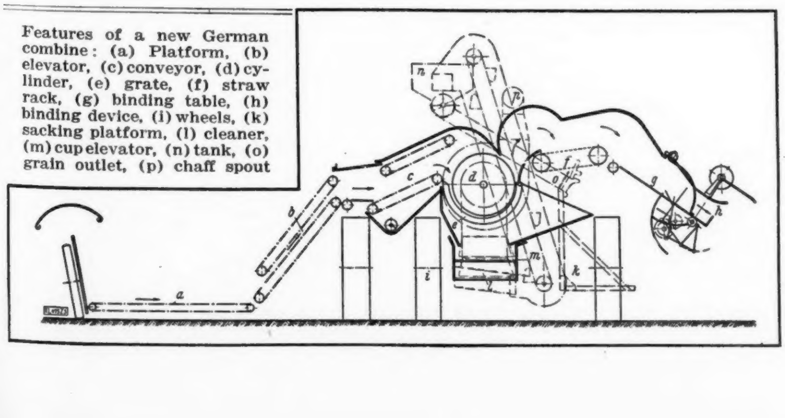
To pull the combine the power of an ordinary four-plow tractor or of six to eight horses is necessary. Total weight of the combine including binder, separator and auxiliary motor, is about three to three and one-half tons. Other combines now used in Germany weigh approximately five to five and one-half tons.

Capacity will depend to some extent upon the width of cut of the binder which is used in connection with the separator. The separator itself is built for a maximum capacity of 4,500 pounds of grain per hour. With a seven-foot binder and with an approximate yield of 40 bushels of wheat per acre, the machine will harvest about 15 acres of wheat in an 8-hour day.

Depending upon weather and other conditions the farmer can either combine; cut the grain with the binder and the thresher in the field separately; or cut with the binder and thresh from the stack or in the shed in the winter time.

A further advantage is that lodged grain can be combined by using the D.I.W. binder, an earlier product of the same company, in connection with the new threshing unit.

The new combine indicates that the designer did not only consider the various mechanical requirements but also had in mind the economic point of view. By its construction it shows greater adaptability to conditions prevailing in central Europe than others built up to this time. The price will be low enough to harvest an acreage of 125 to 150 acres without too high an



Features of a new German combine: (a) Platform, (b) elevator, (c) conveyor, (d) cylinder, (e) grate, (f) straw rack, (g) binding table, (h) binding device, (i) wheels, (k) sacking platform, (l) cleaner, (m) cup elevator, (n) tank, (o) grain outlet, (p) chaff spout

[1]Research assistant, department of agricultural economics, Montana State College.

[2]Investigations of the "Reichskuratorium fur Technik in der Landwirtschaft" (R.K.T.L.)

[3]Deutche Industrie Werke "Spandau," near Berlin.

[4]Articles in "Technik in der Landwirtschaft" Berlin, October 1931, "V.D.I. Nachrichten" Berlin, Oct. 1931.

investment charge per acre, a circumstance which has made it impossible hitherto for many farmers to use a combine. The investment can be made gradually since it is possible to buy it in parts, or if necessary the thresher can be bought in partnership until the necessary cash is available to purchase the rest individually.

Another point, which is generally overlooked in the change from human or animal to mechanical power, is that this change came about so suddenly that the farmer found it difficult to adjust himself and his farm organization to the new methods. This caused great disturbances in agriculture where farmers had to be able to meet competition in order to make a living. Changes in farm organization necessarily come about gradually. Grain from the harvester-thresher is handled in different manner, the help must become accustomed to the new equipment, and the management must arrange the work schedule of the farm differently in order to use the new method to best advantage. The new combine due to its adaptability and double-unit construction allows a gradual transition to power farming methods from those formerly used.

Therefore, the new type of combine presents an appeal not only because it is cheaper, lighter, more versatile, but also because it allows gradual and economic adjustment to a new plan of farm organization.

A New Design for Combine Cylinders

By Otto Schnellbach[1]

ALL HERETOFORE known combined harvester-threshers have been large and cumbersome, because they had to have straw racks to separate the grain from the straw. If it were possible to construct a threshing machine without a straw rack, it would soon be possible to build a cheaper baby combine. Attempts have been made repeatedly to build threshing devices in which the cylinders separated the grain from the straw to such an extent that no straw rack was necessary. Up to the present, however, all attempts have failed.

On a German experimental farm there was a threshing machine running last summer which has contributed a good deal to the solution of the problem—the straw-rackless one-shaft threshing machine for the baby combine. The inventor was Dr. F. Schlayer. From his experiences with straw ripping cylinders on threshing machines he was led to the construction of the axial threshing machine. In it one thick shaft revolves in a housing of sheet iron and has attached to it arms with beater plates arranged in the shape of a screw. The grain is not laid on the entire width of the cylinder as usual, but is fed radially on one side. There are no concaves. The arms with the plates beat the heads against the edge of the inlet opening, threshing out a part of the grains. Straw, heads and grains are then whirled through the threshing chamber by the screw arrangement of the beater plates.

The heavier grains are pressed toward the outside by centrifugal force and fall into a collecting auger through a sieve bottom of the housing. By means of the built-in counter holder, the speed at which the grain travels through the machine is slackened and the cylinder given new opportunity to beat even the last grains out of the heads. In section the threshing chamber is oval shaped, so that the grain is repeatedly thrust out of the whirlwind of the beater arms. It thus comes to rest and then drops and is caught up again by the arms. At the other end of the cylinder there is a small fan, which sucks up the chaff, in case the farmer desires to harvest the chaff separately. A large fan behind this withdraws the straw from the machine and blows it onto the field.

The threshed grain, which is thrust through the lower part of the sieve of the threshing chamber by centrifugal force, is passed by the collecting auger to a small cleaning device and thence into the sacks. The cylinder makes 600 revolutions per minute and with about 14 horsepower has a capacity of about 33 bushels per hour.

This machine was originally constructed for Spanish work and, therefore, had a ripping knife for the straw as well as the beater arms. The knives were substituted by beater plates for the German experiments and the whole machine was driven by a 25-horsepower gasoline engine mounted on the same chassis. Working on the experimental farm near Halle on the Saale the machine was drawn by two strong horses and driven from shock to shock, where two men threw the sheaves onto the feeder. The straw remained in small heaps on the field and was plowed in later. The grain was delivered into farm carts driven beside the machine. They were also drawn by two horses. Thus, the operation required two feeders, two drivers, and four horses. The output was about 1.25 acres per hour.

As a harvesting method, this represents something between stationary threshing and combining. However, the great importance of the machine is that it embodies an entirely new threshing device, which is well suited to be built into a combine; a combine having no concave, the cylinder of which cannot be clogged or choked up; that knows no broken grains—because they are not torn out between steel teeth, but are beaten out in the free fall of the grain; a machine which showed only 0.8 per cent of grain loss in later tests and delivered the grains as clean in the sack as any other machine with simple cleaning; a threshing machine, which, thanks to its single shaft and lack of a straw rack, is cheap to construct and threshes out cleanly even on hilly land; and finally, a machine which, rebuilt as a combine, could have a greater capacity than that shown in the experiments, because the feeding of grain from a cutter bar is much more uniform than from whole sheaves.

[1]Engineer, department for the supervision of agricultural engineering research, German Department of Agriculture. Mem. A.S.A.E.


Two views of the single-shaft, axial-cylinder, threshing machine in operation. It has no straw rack or concaves and threshes with high efficiency even on hilly land

Methods of Alleviating Water Shortages on Irrigation Projects[1]

By G. D. Clyde[2]

WHEN a drought occurs of the severity and wide extent of that which occurred in the Middle West in 1930 and in the western part of the United States in 1931, the people begin to realize their dependence upon water. It makes no difference whether the water is applied to crops natually or artificially, the dependence upon water remains. In the West, where agriculture is dependent upon irrigation, water is the one limiting factor to the potential population. The entire social and economic structure is built upon the adequacy and reliability of the water supply. Water, therefore, is an irrigated region's greatest asset and the barometer of its growth and prosperity.

There is only one source of water, precipitation, which is made up largely of the annual crop of rain and snow. Unfortunately, in most parts of the West this comes during the season when plant life is dormant and water requirements are at a minimum. Precipitation which falls during the growing season over most parts of the West is wholly inadequate to support crop growth. It is common knowledge that without artificial storage the summer water supply, so necessary to crop growth, is limited to that part of the winter precipitation which is retarded from run-off, either by being in a solid form (snow or ice), or by its being absorbed by the earth mantle, later to appear and support stream flow during the season of low precipitation.

Precipitation which falls as rain or snow is the primary source of all water supplies. It is from the accumulated precipitation in the form of snow on the high watersheds of the arid West[3] from which the major portion of irrigation water supplies come. In Utah it is estimated that from 60 to 90 per cent of the total annual precipitation on the high watersheds falls as snow and accumulates throughout the winter, forming the storage from which irrigation water supplies are drawn.

We have just experienced during the past summer (1931) the most severe drought that has occurred in the West since records have been kept. Many projects suffered an extreme water shortage. It is not at all pessimistic to think that an even more dry year may occur.. It has been said by one great scientist that "there is no uniformity in nature." This is particularly true of arid climates. These climates are subject to wide variations in temperature, atmospheric humidity, and precipitation. Wide variations are the rule and not the exception.

The annual yield of creeks, rivers, and underground reservoirs, from which irrigation supplies are drawn, is determined largely by the annual precipitation. When this precipitation is low, stream discharges are low; and when precipitation is high, stream discharges are high.

In the early days of irrigation when relatively small areas of land were supplied with irrigation water the crops lost during low-water years were insignificant, but today when the entire yield of a stream is required to irrigate the area under the ditch a shortage in water supply causes tremendous losses. Further irrigation expansion will increase the seriousness of water shortages, unless special effort is made to develop measures for reducing the serious effects of dry years without resorting to the construction of expensive surface storage reservoirs.

It is, of course, obvious that we cannot regulate the climate. Dry years will occur in spite of our wishes to the contrary. There are, however, many things that may be done to decrease the adverse effects of decreased water supplies, among which are

1. Watershed management
2. Water-supply forecasts
3. Supplemental water supplies by pumping
4. Replenishing ground water supplies artificially
5. Improved methods of distribution and application of water on the farm
6. Fall and winter irrigation.

Watershed Management. There are now irrigated in the eleven western states some 16,204,000 acres, or only 2.41 per cent of their area, and when all of the irrigable area is under cultivation the total area will probably not exceed 5 per cent of the total area. Nevertheless, the water supply is the limiting factor in the growth and development of the West.

The annual rainfall varies from as low as 2 inches in parts of the desert to more than 60 inches on some of the high watersheds. The streams which furnish the water for irrigation are replenished each year from the accumulated snows on the high watersheds. The areas which contribute water to the streams, either over the surface or through the ground, are known as the watersheds of the stream to which they contribute.

In the past, the irrigator has thought of his water supply only at the point where the water is diverted from the river into the irrigation canals. He has not been concerned with where the water comes from, but has only been interested in knowing how much water was in the river at the diversion point. The continued increase in water consumption and decreasing water supplies of the past few years have compelled the focusing of attention on the source of the water supplies.

The major portion of the run-off from western streams comes from areas about 7,000-feet elevation. In Utah only 20 per cent of the state's area lies above 7000-feet elevation, but this area contributes approximately 80 per cent of the total run-off. The high watersheds are natural reservoirs and are the major source of supply for western streams. The climate of the West is marked by two seasons —a wet season (winter) and a dry season (summer). The summer precipitation contributes little to stream flow. The winter precipitation is largely in the form of snow, which on the high watersheds accumulates during the winter; with rising temperatures of spring, the snow melts and furnishes the spring run-off. The snow cover may, therefore, be considered as a huge natural storage reservoir. When the snow melts, a part of the resulting water runs directly over the surface of the ground to the drainage channels, a part sinks into the earth mantle later to appear as run-off from springs, a part is evaporated directly from the snow or soil surface and still another part is utilized or transpired by plants. The water which is evaporated, utilized by plants, or transpired naturally is lost to the run-off. That which seeps into the ground is only temporarily lost to run-off because it goes into ground storage, later appearing lower down to support the late-summer stream flow. It is this late-summer water which is most valuable because upon it depends the extent of irrigation development without expensive artificial storage. The snow cover is ordinarily completely gone by July 1 to 15; after this the stream flow must be supported largely by

---

[1]A paper presented at a meeting of the Land Reclamation Division of the American Society of Agricultural Engineers, at Chicago, December 1931. Contribution from the Department of Irrigation and Drainage Engineering, Utah Agricultural Experiment Station. Publication authorized by the Director, November 23, 1931.

[2]Associate drainage and irrigation engineer, Utah Agricultural Experiment Station.

[3]The term "West" in this paper refers particularly to that area north of Arizona and New Mexico.

ground storage. The Logan River in Utah is a good example of a stream whose discharge is maintained at a relatively high stage by ground storage long after the snow cover has melted. The limestone formation with its many caves and caverns furnishes excellent ground storage conditions. The Weber River, on the other hand, the watershed of which is composed largely of a glaciated granite formation, has little ground storage. The run-off from this watershed reaches a high peak during the snow-melting season and drops off abruptly to an extremely low flow immediately following the disappearance of the snow cover.

The rate of run-off from a watershed depends upon several factors

1. Amount of snow cover and its density
2. Temperature at beginning of or during melting
3. Moisture content of the earth mantle
4. Porosity of the earth mantle
5. Topography
6. Geology
7. Vegetal cover
8. Organic mulch on the surface of the soil.

Of these many factors man may control or partially control only the last two. The meteorological conditions are beyond the power of man to control. The physical conditions are pretty well fixed, at least as far as man is concerned. It is within the power of man, however, to modify in a small way the vegetal cover and the organic mulch which is a result of vegetation. There seems to be a delicate balance between the eroding aggrading forces of nature; any slight disturbance of this balance results in considerable change.

The effect of vegetal cover on run-off and erosion has been the object of intensive research for a long time. Research on the effect of forest cover has definitely shown that vegetation serves to restrain the flow of surface water, causing a greater absorption by the earth mantle and a smaller surface run-off. Lowdermilk[4] has found that mountain areas covered by forest litters maintain higher rates of penetration than do areas from which the litters have been removed. He found that the run-off from the litter-covered areas was clear, while the run-off from the bare areas was extremely muddy. The wide differences in rates of penetration was found to be due not to the mechanical hindrance to flow but rather to the fact that the muddy water from the bare areas soon filled up the pores in the surface soil and reduced the penetration. A vegetal cover, therefore, will decrease the total run-off from an area in proportion to the water consumed or transpired by the plants.

Investigations conducted by the Division of Irrigation of the U.S.D.A. Bureau of Agricultural Engineering on consumption of water by native canyon vegetation in Southern California indicate a consumption of more than an acre-foot of water per acre for the month of May. This includes evaporation as well as transpiration. The loss during June, July, and August was probably greater than that found during May. In reducing the flow, however, it reduces erosion, prevents the destroying of the soil cover, and reduces flood damage. On the other hand, the retarded flow increases the opportunity for evaporation losses, increases the plant consumption and plant transpiration, thus reducing the total water yield from a given watershed.

In an irrigated region, the net yield from a watershed may be considered to be that amount of water which is available for crop production. If the water runs off before the growing season or during the early growing season, when water requirements are low, it cannot be utilized and is, therefore, lost. Run-off which occurs in floods or spring freshets, unless artificial surface storage is available, for the most part is lost to the irrigator.

[4]"Studies of Factors Affecting the Yield of Water from Watersheds in Southern California," by W. C. Lowdermilk, senior silviculturist, California Agricultural Experiment Station, an address delivered before the Irrigation Division of the American Society of Civil Engineers, March 27, 1930.

There is no doubt but the total run-off from a denuded area will be greater than from a forested area, but its distribution may be such that the net yield to the irrigator would be much less than from a forested area. It should be recognized that a forested area consumes more water than a barren one, but that the advantages provided by a forest cover in regulating the stream flow may more than offset the disadvantage of a decreased total yield. Watersheds should be managed to yield the greatest total good to the public. Proper management is vital for the greatest utilization of water supplies, forest resources, and for protection from flood damage. Watersheds are the natural reservoirs through which the run-off is equalized so that it may be used by man in the production of crops. The preservation of the water-absorbing power of the watersheds is necessary not only for future development but for the protection of existing investments.

The time has come when every person who has a water right in any stream is just as vitally concerned in the management of his watershed as he is in the maintenance of his irrigation works. Careful management is necessary if the watersheds are to be made to yield a maximum beneficial water supply with a minimum damage from erosion. Nothing will serve more to reduce the effects of drought than a knowledge of watershed conditions and well-developed plan of watershed management. Further education of the farmer in the value of his watersheds and more research to provide a basic knowledge of watershed conditions are urgently needed.

Forecasting Water Supplies. A knowledge of physical conditions on a watershed alone is not sufficient to permit of the maximum utilization of water supplies. It is necessary also to know the relationship between conditions on the watershed and the resulting run-off.

The major portion of the run-off in western streams comes from the high watersheds. In Utah approximately 80 per cent of the run-off comes from areas above 7,000 feet in elevation. The accumulated snow cover is, therefore, the major source of the run-off from most western streams. Weather records are collected by the U. S. Weather Bureau at a large number of stations; few of these stations, however, are above 7000-feet elevation. As a result, there is a general lack of reliable precipitation and other meteorological data on high watersheds in spite of the fact that these areas are the major water-producing areas for irrigation as well as for domestic and power purposes. To make the most complete use of the water resources of any area not well supplied with artificial surface storage, it is necessary, not only to know how to apply the water after it comes, but also to know the characteristics of the producing areas in order that it may be determined when and in what quantities the water will come. Therefore, a knowledge of the precipitation on and the run-off from the high watersheds is vital to the proper utilization of the West's water resources.

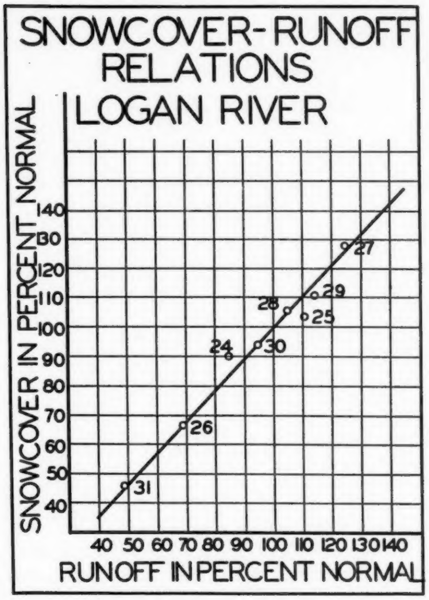
The water-producing areas for the most part are uninhabited and extremely difficult of access during the winter; as a result, few data are available as to the actual meteorological conditions on them. On the high watersheds the snow falls and accumulates during the winter with little

In this paper it has been possible to consider only a few of the methods of alleviating water shortages, but it is believed the methods outlined are basic and that with more research and study they may be widely utilized to reduce the effect of the seasonal variation in water supply on those irrigation projects not provided with ample artificial storage

or no loss by winter melting. A measurement of this snow cover at the end of the winter precipitation season and before melting begins furnishes a good index of the potential water supply for the following season.

At present the only feasible method of obtaining the needed information on the high watersheds is by making seasonal snow surveys over the watersheds at the end of the winter-precipitation season.

It was recognized as early as 1800 that the snow cover played an important part in the amount and time of run-off, but it was not until a hundred years later that methods of measuring the snow cover were developed and used to any extent. The density of snow varies widely from year to year and from place to place, so that depth measurements alone are not indicative of the potential water supply in the snow cover.



The first method of determining the density of snow cover was to cut out a core of snow of known volume and to melt it and then to measure the volume of water. In 1909 Dr. Church of the University of Nevada developed a method of cutting out a known volume of snow and weighing it to determine its water content. This method is accurate and the equipment convenient to handle in the field. The Church equipment is now the standard equipment used for density determinations.

Recognizing the importance of a better knowledge of water-producing areas of the state, the Utah Agricultural Experiment Station in 1923 began a study of the relationship between the precipitation on and the run-off from the high watersheds of the state. Such a study required (1) the measurement of the precipitation and other meteorological data on the watersheds and (2) the measurements of the run-off from the watersheds.

The topography of most western watersheds is extremely rough, and it is difficult, if not impossible, to determine precisely the total amount of water on the watershed at the end of the winter precipitation season. If the total water content were determined the total losses from the watershed would also have to be determined before the run-off could be evaluated. These losses, such as evaporation, transpiration, deep seepage, and water consumed by plants, depend on many factors which are in themselves difficult to determine. As the physical conditions on a given watershed remain essentially constant, and as the vegetal cover does not change much from year to year unless disturbed by man, the losses will remain more or less constant for a given area. The snow cover is the largest single factor which affects the run-off; if the physical conditions on a watershed are more or less constant, then the snow cover, its extent, density, and rate of melting should be a measure of the run-off. Therefore, there should be a definite relationship between the snow cover and the run-off from a given watershed.

The depth and water content of the snow cover on a given watershed is determined at the end of the precipitation season by a system of snow surveys over representative portions of the watershed. These surveys are made by measuring the depth and water content at regular intervals over established courses. The courses are located over representative areas and are carefully described so that the measurements are made in the same place each year. The courses, located so as to be as free as possible from drifting winds and above the line of winter melting vary in length from 2,000 to 5,000 feet. Measurements of depth and water content of the snow cover are made at 50-foot or 100-foot intervals, depending upon length of course. Establishing snow courses and making snow surveys is described in detail in Utah Agricultural Experiment Station Circular No. 91 (1929).

Briefly, the equipment for measuring the water content of the snow cover consists of (1) a seamless steel tube, 1.75 inches outside diameter with a milled cutter, having an inside diameter of 1.485 inches, fastened in the end of the tube; (2) a spring balance for weighing the core; and (3) a tape for measuring the distance between points of observation. The tube is thrust vertically downward through the snow and a core cut out. This core is weighed, the weight in ounces equaling the water content of the snow cover in inches. Under normal conditions about thirty observations per hour may be made with this equipment.

In studying the relationship between snow cover and run-off, it must be remembered that this relationship is affected by several factors besides the snow cover: Geological, topographical, earth mantle, vegetal cover, temperature, soil moisture at beginning of precipitation season, and spring and early summer rains. On most high watersheds, however, the most important single factor is the snow cover; on many streams the snow cover alone gives a good basis for forecasting stream flow. Every stream seems to be a "law unto itself," and the snow cover run-off relationship must be worked out for each individual stream.

Stream flow forecasting is based on the assumption that a normal snow cover will produce a normal run-off. This assumption is not strictly correct due to the other factors mentioned affecting the run-off. By measuring the snow cover for a number of years and plotting the snow cover against the run-off, the relationship is determined. This relationship must be modified if abnormal precipitation or temperatures occur after the snow survey. Once this basic relationship has been determined for a particular stream, a measurement of the snow cover at the end of the precipitation season will indicate the anticipated water supply during the following summer months. The longer the record the more accurate the determination of the snow-cover-run-off relationship.

There are now eight years of record on the Logan River, Utah. This short record, even though it is practically all in a dry cycle, points to a close correlation between the snow cover and run-off. The snow cover in percentage of normal was plotted against run-off in percentage of normal. This curve is shown in the graph accompanying this paper. It will be noted that for the eight years of record five of the points fall on a straight line and the widest divergence of any point is less than 5 per cent. The forecast for the July-September run-off was based on this curve and the actual run-off was within 2 per cent of the forecasted run-off.

Within the last two years a network of snow survey courses has been established, covering the principal watersheds of Utah. As soon as sufficient records are available water supply forecasts based on these surveys will be made for the principal streams of the state. California recently inaugurated a system of snow surveys covering the principal watersheds of the state, and Nevada has for many years been forecasting water supply based on snow surveys.

The principal losses which follow water shortages are due to the crop failures caused by lack of water to mature the crops. A knowledge of the water supply in advance of

the planting season will enable the farmer to so plan his crops that he can mature what he plants. If he is assured of a high-water year he may expand his late-season crops, if he faces a low-water year he will surely restrict his planting rather than suffer an inevitable loss due to lack of water. Stream-flow forecasts issued on April 1, 1931, for northern Utah streams indicated a water supply not more than 50 per cent of normal. As a result, sugar-beet[5] plantings were restricted, the less productive lands were temporarily abandoned, and plans were made to concentrate the available water on the more productive acres. The result was that although the water supply proved to be a little less than 50 per cent of a normal supply, there were no crop failures in that area due to lack of water. A pre-season knowledge of the available water supply is one of the best means of reducing the losses which result from inevitable water shortages on irrigation projects.

Supplemental Water Supplies by Pumping. There are two sources of supply for pumped water: (1) Surface waters and (2) subsurface waters. Whenever a shortage of water occurs in surface streams there also occurs a shortage in surface waters available for pumping. Subsurface water supplies are drawn from ground storage in the unconsolidated valley fill. The total storage capacity of this material is many times that of artificial surface storage. During wet years, these ground water basins are filled, and during dry years most of the water in them naturally remains in storage as the water losses from ground water basins with a low water table are relatively small. For many years it has been known that these immense storage basins existed and that large water supplies could be obtained from them by pumping. Pumping machinery has been improved in the last 25 years until now pumps with an efficiency of 75 per cent are not at all uncommon. Methods of constructing wells have been developed, so that almost any formation may now be drilled.

Up to the present pumping has been resorted to only when gravity waters were not available, except at high cost; nevertheless, large areas are now supplied with water from ground sources. The series of dry years through which the West has just passed has emphasized more and more the need for supplemental supplies for gravity irrigation systems. As the projects become more completely developed a need for more water develops; when short-water years occur great losses are sustained due to lack of water. Supplemental water supplies may be obtained by artificial surface storage or by pumping if ground storage is available. Artificial surface storage is costly and will continue to become more costly as the available natural reservoir sites are used. Pumping ground water to supplement the natural flow during short-water years is being resorted to more and more.

In many irrigated sections it is possible to drill wells in such locations that they may be pumped directly into the canals and the water used to supplement the surface supplies. When this is possible it seems to offer the best insurance against loss due to shortage in surface water supplies. A permanent supplementary supply of water from ground sources will permit of a greater utilization of the surface water supplies without artificial surface storage, because ground water supplies are available upon demand. Any amount of water may be drawn from the ground storage of a given basin up to the amount of the average annual recharge to the basin so that a ground water supply dovetails nicely with a surface supply to permit of maximum use of the surface supply during wet years and still sustain minimum loss due to water shortage during dry years.

Replenishing Ground Water Supplies Artificially. The fact that the water from ground storage cannot be seen until it comes from the well has led many people to believe erroneously that the supply of underground water is inexhaustible. Ground water supplies are limited in capacity the same as a surface reservoir is limited in capacity. If more water is taken out of the reservoir than is put back in over a period of years, the reservoir will go dry.

In many areas, particularly in Southern California, the draft from ground storage during the past several years has exceeded the recharge; as a result the static water level has continued to drop until the economical pumping limit has been passed and in some cases salt water has filtered into the wells. A. T. Mitchelson, senior irrigation engineer of the U.S.D.A. Bureau of Agricultural Engineering, reports that in the region bordering the southern area of the San Francisco Bay in three typical wells since 1915 the static water level has lowered 74, 82, and 62 feet, respectively. In the Escalante Valley, in Utah, the static water level has for the past several years been steadily dropping at the rate of about 1 foot per year. In the Fillmore area, Millard County, Utah, the static water level dropped 7 feet in one year. In the artesian-well area, west of Fillmore, Utah, a well which flowed 13 cfs in 1923 has now stopped flowing and the water stands 13 feet below the ground surface. Near Santa Anna, California, there are approximately 40 square miles under which the water-table has dropped to a point where there is now great danger of infiltration of salt water from the ocean. These many instances of decrease in the static level of the ground water emphasize the fact that ground water supplies are not inexhaustible and that no more water can be taken out than is put back in. In those areas where the total water supply comes from the ground-water sources, steps must be taken either to increase the annual recharge to the ground water basins or to decrease the annual discharge from the basins. People who are obtaining ground water to supplement their gravity flow, should see to it that the ground-water basins from which they pump during dry years are recharged during wet years and dry years alike.

Water-spreading artificially to recharge ground-water basins has been practiced for many years, but it has only been about four years since this problem has been studied scientifically. The Bureau of Agricultural Engineering of the U. S. Department of Agriculture, under the direction of W. W. McLaughlin, led in these researches.

The alluvial fans and deltas at the mouths of most canyons in the West and Southwest offer ideal sites for water-spreading grounds. In Southern California many water companies and municipalities have developed and are operating water-spreading works. These works usually consist of diversion dams and channels to convey the waters from their natural stream channels across the gravel fans until it is absorbed. As silty water soon clogs up the surface soil, tunnels, wells, and pits have been used to increase the infiltration area. The U.S.D.A. Bureau of Agricultural Engineering operated an experimental plot near the mouth of San Gabriel Canyon, California, during 1930. The plot was approximately 80 feet wide and 200 feet long, containing 0.38 acre. Water was spread over this area for 87.5 days; the average daily percolation rate was 3.98 acre-feet. The total amount applied during the season was 398 acre-feet per acre. Since 1911 the Orange, San Bernardino, and Riverside Counties water conservation association have been spreading water to replenish their ground waters. In 1921-22 they stored 81,000 acre-feet. There was stored in the San Gabriel cone in 1929-30, on a tract not over 40 acres in area, a total of 12,000 acre-feet. These are only a few examples of water-spreading being conducted at the present time.

Ground-water supplies may be replenished artificially the same as a surface storage reservoir may be filled. Flood waters and surface winter flow should be spread wherever possible to maintain the ground water supplies at a maximum. It is a well-known fact that dry years have occurred in succession and will occur again, and it is when such a series of dry years do occur that the ground storage must be drawn upon to supplement the gravity water and in many cases to furnish the full supply.

Water-spreading methods should be improved and the practice extended to all areas where it is feasible. Full

[5]Sugar beets are seldom irrigated before July 15, but they require irrigations at about two-week intervals during August and September.

ground storage accessible to pumps and within the economic pumping limit, when a dry year or a series of dry years occur, is like having a good bank account during a financial depression.

Distribution and Application of Water. The methods of reducing the effect of water shortages on irrigation projects discussed have dealt with the water supply before it reached the farm. What can the farmer do to reduce his losses if he is faced with a short water supply?

Many irrigation companies in the West still use the continuous delivery system of water distribution. This system gives each user a continuous stream which is usually extremely small. He cannot apply his water economically, his seepage losses are high, and the cost of applying the water exhorbitant. There are few cases where the rotation system will not serve the farmer better, lower his irrigation costs, and decrease his seepage losses. It will make available a large head of water which can be applied more economically. During this past year (1931) in which a severe water shortage occurred, many systems were unable to irrigate under the continuous delivery system because these streams were so small they were entirely lost by deep seepage. They adopted a rotation system, and those who were already on the rotation system doubled up their streams and took shorter turns to increase the efficiency of their irrigation water. More dry years are coming. Prepare for these dry years by organizing better methods of distribution so that economical sized streams may be maintained.

The summer of 1931 was the driest of record in Utah. The water supply available for irrigation was less than 50 per cent of normal. Those farmers whose farms were well prepared for irrigation suffered the least from the shortage. Those farms whose surface had not been prepared for irrigation, whose runs were too long on open soils and too short in heavy soils suffered materially from the water shortage. The farmer who stayed with his water and crowded it over the surface, prevented both deep percolation and surface run-off losses and produced good crops, while his neighbor with the same amount of water sustained a partial crop failure. The lesson to be learned from this season's experience is that the best insurance for the individual farmer against the dry year is for him to (1) prepare his land for irrigation and (2) to learn to irrigate properly.

Fall and Winter Irrigation. A soil well filled with moisture at planting time is in a much better condition to face a short water supply than one which starts out with a deficient supply of water. To reduce the effect of dry years, study the soil moisture and maintain its moisture content at an optimum by irrigation, even if the water has to be applied in late fall or early winter. If the moisture supply is deficient in early spring, take advantage of the spring flood waters and replenish it. Be prepared, a dry year may come any year, but if the moisture content is up in the spring, the plants will at least get off to a good start.

SUMMARY

Dry years have occurred and they are bound to occur again. As more land is brought into cultivation the dry years will be more noticeable because the shortages will affect more people, and their effect will be more severe. For this reason preparation should be made now to alleviate the effect of water shortages that are bound to occur at intervals on irrigation projects. The disastrous effects of water shortages may be lessened by

1. Developing a system of effective watershed management before the next dry year occurs
2. Developing and utilizing methods of forecasting stream flow prior to the planting season
3. Providing supplementary water supplies from ground sources and developing methods of recharging ground-water basins artificially
4. Improving the methods of distribution after the water is diverted from the stream and improving the methods of application on the farm
5. Practicing fall, winter and early spring irrigation where necessary to maintain optimum soil moisture conditions.

In this paper it has been possible to consider only a few of the methods of alleviating water shortages, but it is believed the methods outlined are basic and that with more research and study they may be widely utilized to reduce the effect of the seasonal variation in water supply on those irrigation projects not provided with ample artificial storage.

AUTHOR'S NOTE: Acknowledgment is hereby gratefully given to Mr. W. W. McLaughlin, chief, irrigation division, Bureau of Agricultural Engineering, U. S. Department of Agriculture; to Mr. A. T. Mitchelsen, senior irrigation engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture, for data on methods of water-spreading to replenish ground water basins; and to Mr. William Peterson, director, Utah Agricultural Extension Division, for suggestions on water-shed management.

Soil Heating Investigations[1]

STUDIES IN SOIL HEATING and the heating of hotbeds with electricity have been continued. The project has been enlarged. Four 6x12-foot hotbeds have been equipped. A garden nearly 100 feet square has been fenced in and planted largely to rhubarb and asparagus. Insulated heating elements have been buried in the soil beneath half of the plants. Some of these have had a season's growth, although no data were taken, it being felt that the first season's crops would be no true indication of what might be expected in subsequent crops.

The four hotbeds differ from each other in design. In one of these lead-covered resistance wire is laid on a bed of cinders about eight inches deep. This is covered with about six inches of soil. Another has the lead-sheathed heating unit buried directly in the soil. The third uses the same kind of heating unit as the two just mentioned, but is equipped with a slat bottom just above the heating wires, which lie on the ground. Flats 15x22x5 inches are used, the object being to keep the roots and tops of the plants at about the same temperature. The fourth hotbed has a false bottom completely covered with soil. The heating elements consist of spiraled nickel-chrome wire. These coils are supported on porcelain insulators. Otherwise they are not in contact with anything which might result in grounding or short circuiting.

Investigations in the rate of heat travel through the soil have been continued. Not much data were collected during the early part of the year, as the weather was not cold enough to make satisfactory tests.

It is very difficult to eliminate some variables in making these tests, which means that if reliable data are to be obtained, many trials must be made. Among the worst of the variables are changes of moisture conditions in the small samples with which it is necessary to work.

It was gratifying to note that we were able in a few cases to start apple cuttings with the electrically heated hotbeds. The starting of apple cuttings has baffled horticulturists for many years. Although but a small per cent of the cuttings tried took root, the results were encouraging, and further studies by the division of horticulture may reveal the proper conditions of root and top temperatures for making this method successful. The advantage of stock started in this way is that the hardier northern varieties may be used, which should reduce the susceptibility to winter injury.

[1]From 1931 progress report, Washington Committee on the Relation of Electricity to Agriculture.

Some Proposed Standard Measurements for Kitchen Equipment[1]

By Deane G. Carter[2]

THE method of kitchen design and proposed standard measurements for kitchen equipment presented in this paper are the results of studies conducted by the author during the past several years at the Arkansas Agricultural Experiment Station. A research project conducted cooperatively by the station and the Committee on Kitchens of the President's Conference on Home Building and Home Ownership afforded an opportunity to work out details of design and application.

The justification for a consideration of standard measurements is based upon the following facts:

1. Cost is the limiting factor in housing at ordinary levels[3]
2. A large proportion of farm kitchens are lacking in equipment, or the equipment is inadequate[4]
3. Studies in urban housing indicate a 50 per cent lack of kitchen storage equipment in many groups of homes[6]
4. At present the size and shape of kitchens is largely "accidental." Arkansas farm kitchens average about 12 by 14 feet in size, or much larger than the minimum requirements.[6] Houses designed by architects include a wide range of sizes[5]
5. "Sixty-one per cent of the families (in 73 cities) pay rent under $35.00 a month. It is in providing adequate housing for this 61 per cent of the population that the chief housing problem consists"[7]
6. "Sixty-one per cent of the population have average incomes of $2000 or less"[7]
7. The useful life of the house is greater than the period of occupancy by one family. The average occupancy of farm homes is about 13 years."[8]

In addition to these established facts, it is well known that a rather large proportion of present-day construction is "speculative" in that the homes are built for sale or rent, rather than specifically for the individual owner. The percentage of tenancy is high, both in urban and rural situations.

[1]Research Paper No. 257, Journal Series, University of Arkansas. Released for first publication in AGRICULTURAL ENGINEERING.

[2]Professor of Agricultural Engineering, University of Arkansas, College of Agriculture. Mem. A.S.A.E.

[3]Carter, Deane G. Basic Factors in Farm House Planning, Agricultural Engineering, Vol. 11, No. 9 (1930)

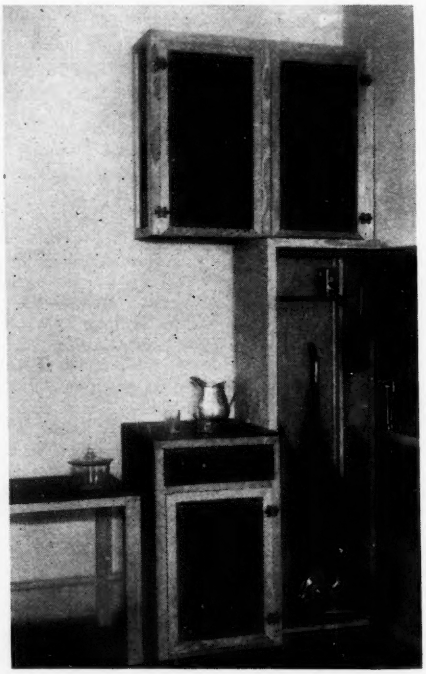
[4]Carter, Deane G., and Johnson, Madge. Built-in Equipment for Home Convenience. Arkansas Extension Service Circular 244 (1927).

[5]Marlatt, Abby L. Kitchens and Other Work Centers — Preliminary Mimeograph Report for President's Conference on Home Building and Home Ownership (1931).

[6]Unpublished data, Arkansas Agricultural Experiment Station.

[7]Whitten, Robert, and Adams, Thomas. Neighborhoods of Small Homes, Harvard University Press (1931).

[8]Carter, Deane G. Farm Housing in Arkansas. Journal of Home Economics, Vol. 23, No. 7, pp. 616-622 (1931).



Broom closet, high section, base section, and table which are among the units of cabinet or kitchen equipment designed according to the standard measurements proposed

From one foregoing, it would appear that the design and equipment is not, in a majority of instances, a special problem to meet the desires of the individual, but is rather a problem to be solved according to normal or general requirements. Any method designed to effect improvement at lower cost is worthy of consideration. The lower income groups include well over half the total population.

For those homes where income or investment is necessarily limited, where adequate equipment is not now available, and where the house is not designed to personal requirements, it is obvious that best results can be secured by designs worked out on the basis of normal requirements, typical measurements, and simplified low-cost construction methods.

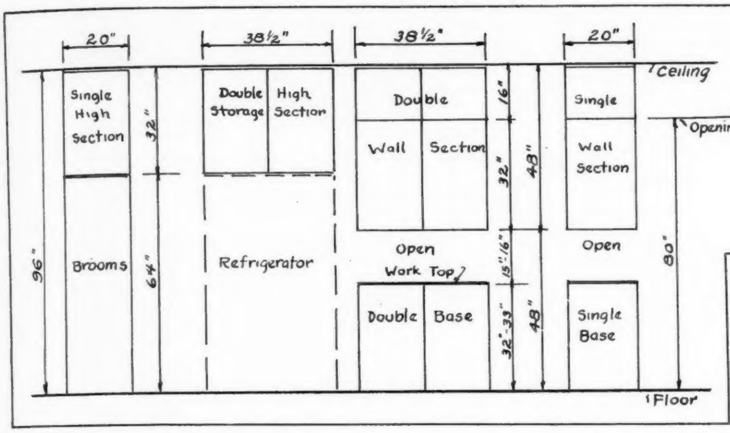
Under present methods of kitchen and equipment design, each item of cabinet work is built "on the job" to individual measurements, to fit the space available. This method involves relatively high costs for materials and hand labor, and prevents any effort toward mass production. In cases where manufactured equipment is used, the selection must be from ready made units. Manufacturers are therefore compelled to carry a very wide range of sizes to meet the demands.

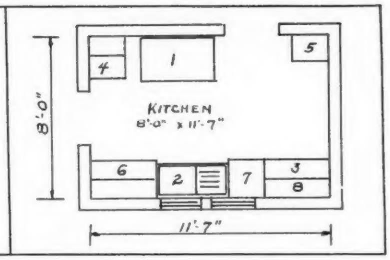
From studies made of the application of designs to existing kitchens it is appareut that minor changes only in kitchen planning would be necessary to reduce the number of sizes. It is not necessary to standardize either size or shape of kitchen, to take advantage of standard measurements. It may be assumed that the typical kitchen in the detached, single-family house has two outside exposures, outside natural light, and a minimum of two doors and two windows. Doors are already quite standard in width at 32 inches. Windows are available in a range of sizes, and casing widths can be varied by one or two inches. Doors and windows can usually be moved a few inches either way without materially affecting the plan. Unless some special requirement is involved, a change of less than one foot in width or length, or both, in the original plan will not complicate the design. In studies made a change of two to four inches in size is often all that is necessary.

The logical starting point in the design for standard equipment is to accept such areas and measurements as are already established by custom or necessity. Normally the kitchen will include stove, sink, and refrigerator, in addition to the storage and cabinet equipment.

ASSUMED STANDARDS

Based upon the foregoing, it is possible to set up certain tentative standards. It should be noted that the proposals which follow involve the mechanical or building problems exclusively. Considerable research is under way involving fatigue, time, motion, and routing. However, it is not the purpose here to include these factors as a definite part of the study.





(Left) Wall space for standard equipment units. (Above) Small kitchen plan for proposed standard equipment. 1. Stove. 2. Sink. 3. Refrigerator. 4. Single base and wall section. 5. Auxiliary case and single high section. 6. Double base and wall section. 7. Single base section. 8. Double high storage section over refrigerator

Doors. A door width of 32 inches is the present common standard.

Windows. Window openings may be selected in any desired or necessary size from standard stocks.

Openings Height. Six feet 8 inches — or 80 inches — is the accepted standard height of openings for average houses.

Ceiling Heights. The height of ceilings varies from about 7 feet 10 inches to more than 9 feet. A common height for average and low-cost houses is approximately 8 feet. Since a height of 96 inches involves no complication in design, it is assumed tentatively as a standard.

Mechanical Equipment. While it would be possible to manufacture utilities equipment to exact standards of measurements, the complication and time required to effect such a procedure presents a serious obstacle. Practically, it is possible to allow areas for the normal or probable maximum sizes of utilities equipment. Common sink sizes are 20 and 22 inches front to back, and 30 and 42 inches length. Most types of stove or cooking equipment require a floor area not greater than 26 by 42 inches. Refrigerators seldom exceed 24 inches depth, 36 inches width, and 64 inches height.

Minimum Kitchen Width. For an oblong or square kitchen, the minimum width with equipment on opposite sides is 7 feet. Normally the equipment occupies approximately 2 feet of space on either side. Since the minimum space for the worker is set by a number of authorities at 30 inches, since a door in the end wall requires 32 inches, and since short hallways for passage elsewhere in the house are usually 42 inches, it is evident that 3 feet of free space is about a minimum requirement.

Storage Equipment Requirements. The basic cabinet work required for a normal kitchen can be derived from observation and analysis, and from experience in the design of adequate equipment. It was noted previously that, for a majority of kitchens in the lower cost ranges, present equipment is inadequate. Therefore, to meet a desirable standard the normal amounts and types can be assumed to be as follows:

1. Base sections with work top and storage space below
2. Wall cupboards or cabinets for use above work top
3. High shelves or cases for supplementary storage
4. Auxiliary cases for brooms, mops, cleaning supplies, utensils, canned goods, and the like.

Work Surface Height. The normal working surface for a person standing is 33 inches, plus or minus one inch to meet the needs of a large majority[9].

Open Space Above Work Surface. Sufficient space is required to allow for average tall articles on the work surface, to enable the worker to see most of the counter top, and for convenient working. Fifteen inches is apparently suitable, with a variation from 14 to 16 inches depending upon the exact work surface height.

Wall Cupboard Height. Since the sum of the working surface and open space above totals 48 inches, the wall case height is set at 48 inches to extend to the ceiling, or

[9]Carter, Dean G. Kitchen Work Surface Height, Annual Report, Arkansas Agricultural Experiment Station Bulletin 257 (1930).

Table I. Standard Measurements for Kitchen Equipment (Proposed 8-inch module)

Item	Dimension	Normal measure (inches)	Proposed measure (inches)	No. of 8-inch modular units	Modifications necessary
Doors	Width	32	32	4	No change
	Height	80	80	10	No change
Ceiling	Height	94-108	96	12	Standardized at 8 feet 0 inches
Base section and working surface	Height	33 ± 1	32	4	Set on floor or 1 or 2 inch base for adjustment
	Depth	22	24	3	Increase by 2 inches
	Width (single)	20	20	2.5	Double, 38½ inches Triple, 57 inches
Open space over work top	Vertical	14 to 16	16	2	Vary with work surface height
Working surface plus open space	Vertical	48	48	6	No change
Wall cases	Height	48	48	6	No change
	Depth	12¼	12	1.5	Reduce ¼ inch
	Width (single)	20	20	2.5	Double, 38½ inches Triple, 57 inches
High storage cases	Height	32	32	4	No change
	Depth	12¼	12	1.5	Reduce ¼ inch
	Width (single)	20	20	2.5	Double, 38½ inches Triple, 57 inches
Auxiliary cases	Height	60 to 72	64	8	Set average height
	Depth	16	16	2	No change
	Width (single)	20	20	2.5	Double, 38½ inches Triple, 57 inches

32 inches to extend to the openings height, thus naturally making the wall cupboards in 32 and 16-inch divisions.

High Storage Section. The space between maximum refrigerator height of 64 inches and ceiling height of 96 inches gives the measure of high storage cases as 32 inches, identical with the lower portion of the regular wall cupboards.

Auxiliary Cases. Brooms or other handled tools require a vertical space of about 5 feet. Since the 64-inch refrigerator space and the 32-inch high-storage cabinets occupy the 96-inch space from floor to ceiling, 64 inches becomes the logical measure of these cases.

Depths of Cabinet Work. It is possible to develop a complete set of cabinet work with three measurements of depth. Work top or base sections are normally 20 to 24 inches deep. The depth of the sink (22 inches) offers a logical measure, or the depth may be 24 inches, permitting a 2-inch ledge in front of the flat rim sink. Or there might be a 2-inch offset at the sink. In our research study 22 inches was adopted. However, there is no essential reason why 24 inches should not be used.

Wall cases are usually of a depth that permits the use of a nominal 1-by-12-inch board for sides and shelves. The exact measure used was 12¼ inches, or 12 inches is a satisfactory unit of depth.

Auxiliary cases may be as narrow as 12 inches, or as deep as 24 inches. In this design an intermediate depth of 16 inches was taken as standard, to afford a greater choice in selection and to meet the apparent requirements.

Linear Cabinet Measurements (Width). The foregoing discussion establishes, tentatively at least, all of the areas and wall openings at typical, maximum or standard dimensions. The remainder of the wall space is theoretically free for utilization by cabinet and storage items. Essentially the dimensions so far given are, for the most part, the usual figures used in kitchen design.

The obvious problem in standardization is to develop a unit or measure of width that most nearly fits into the normal kitchen. The requirement seemed to be a unit that could be used singly, or in multiple. It is undesirable that a single section should be much narrower than the depth. Multiple sections should span the space normally allotted to kitchen cabinet work. A space of 3 to 3½ feet seemed to be the normal space for each cabinet in a number of plans. The same space accommodated a refrigerator.

The "unit" of linear cabinet measure was selected as 20 inches. This figure was an arbitrary one which met the requirements set up. In the designs, however, it was noted that in double and triple sections the common facing or trim between adjacent units required a variation in width of doors and drawers. Therefore, the 20-inch unit was adopted as the single-section width, and each additional section reduced by the width of one facing. The standard linear measures then become: Single, 20 inches; double, 38½ inches; triple, 57 inches.

Standard Module for Kitchen Equipment. The study indicated that except for the utilities equipment for plumbing, refrigeration and cooking spaces, for which maximum allowances must be made, the assumed standard measurements were quite uniformly multiples of 8 inches. Door width (32 inches), openings height (80 inches), ceiling height (96 inches), wall section height (48 inches), high storage cases (32 inches), auxiliary cabinets (64 inches) are all based upon multiples of 8 inches. By a slight modification of measurements adopted originally, the entire equipment design might be based upon a standard modular unit of 8 inches. The exception would be the multiple section cabinets where the linear measure would be reduced by the width of one facing for each additional unit.

A rather high degree of flexibility in planning is obtained by the use of standards, as the units are almost completely interchangeable, and can be built to exact heights of 80 inches (openings height), or 96 inches as may be desired.

The fact that the suggested module of 8 inches is one-half the usual stud spacing, and since three units total even lineal feet, there is a possibility that the unit would fit well into structural requirements.

Adaptation to Metric System. The meter, equivalent to 39.37 inches, is almost identical with five 8-inch modules. The 8-inch unit could be modified to exactly 20 centimeters, and the entire design based upon the 20 centimeter unit.

Result of Adoption of Standard Units. A general adoption of standard measurements would simplify the problem of kitchen planning, and reduce the number and sizes of stock carried by the manufacturer and dealer. The natural result would be an improvement of quality and lowering of cost through standardized production methods. Standard units invite simplified methods of construction.

A later paper will deal with a simplified low-cost construction method applicable both to special and standard designs.

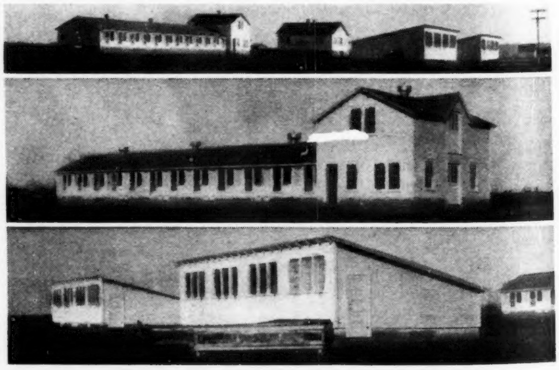
An Experimental Poultry Plant

By Deane G. Carter[1] and R. M. Smith[2]

THE ILLUSTRATIONS show the first unit of a new experimental poultry plant recently completed on the experiment station farm of the University of Arkansas college of agriculture. The plant has a capacity of 800 laying birds, incubator and brooder equipment, battery brooding room, offices, class room, and feed and equipment storage. Electricity, hot and cold water, sewage disposal, and plumbing are included. About 6000 feet of insulation fiber was used in the plant.

Feeding, brooding, breeding, and production projects are carried on by the animal industry department. Two houses, with a capacity of 400 birds have been set aside for engineering studies on the effect of housing factors on egg production. The project plans contemplate studies of equipment, open and closed fronts, insulation, temperature control, humidity, and artificial lighting methods.

Plans for this experimental plant were prepared by the agricultural engineering department of the University.



(Top) General view of the new experimental poultry plant at the University of Arkansas. (Center) Feed house and laying house. (Below) Houses for experimental engineering study of housing factors

[1]Professor of agricultural engineering, University of Arkansas. Mem. A.S.A.E.

[2]Instructor in poultry, University of Arkansas.

Operation of Rice Driers in California with Low Air Temperatures[1]

By George P. Bodnar[2]

RICE, the commercial product sold to the consumer and known as head rice to the rice trade, consists principally of whole rice kernels from which the hull and bran have been removed. The commercial products of other grains usually consist of a flour or meal. In the harvesting, handling and processing of rice the preservation of the kernels in their whole state is highly important. The methods of handling rough rice and preparing it for milling therefore differ in some respects from those used in handling wheat or other grains.

One common cause of the breaking of rice kernels in milling is the checking of the kernels in the field. A check in a kernel of rice, which is flinty in comparison with many other grains, is a partial fracture in the kernel resulting from strains produced in the kernel when the rice is exposed for too long periods to the sun, hot winds, rapid changes in moisture content, and too rapid fluctuations in temperature and humidity. Climatic changes that occur between the day and night and from day to day in California are sufficient to check rice when it is permitted to cure in the field under natural conditions, as in standing, shocked, or windrowed rice. A checked kernel may have one or more of these fractures which may be partial or complete as regards any cross-section of the kernel. While not every checked kernel will break up in the milling process, still many of them do break up in milling because of their weakened condition with a resulting low yield of whole kernels.

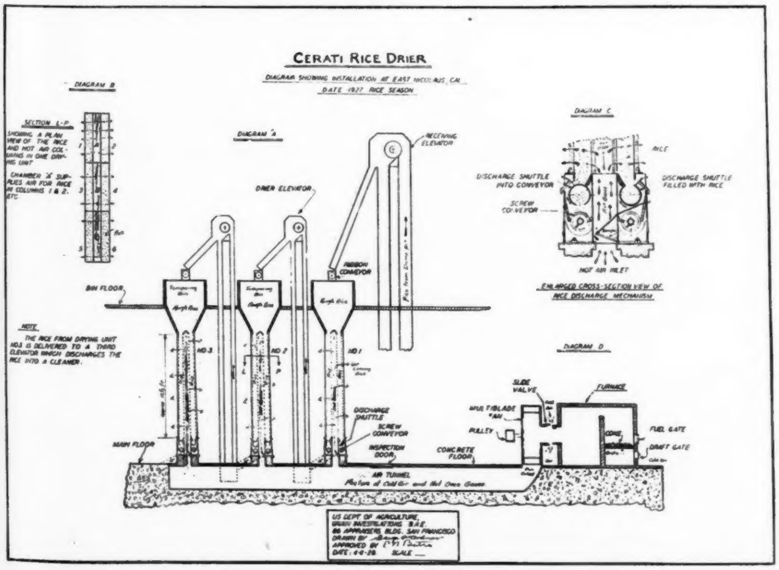
The importance of getting rice out of the weather as early as possible to reduce checking is well illustrated by field tests[3] on the development of checking in rice at the Cortena Rice Experiment Station in California in the 1928 harvest season. Tests on the rice showed that at the time of draining of the water from the standing rice there was only from one to two per cent of checked kernels in the rice. Approximately seven days later at the time of cutting and shocking of the rice approximately 32 per cent of the kernels were checked. Thirteen days after the shocking operation the rice contained 62 per cent of checked kernels. At the beginning of the study the moisture content of the rice was approximately 25 per cent, and a few days before the completion of the tests the moisture content was 10.5 per cent. Air temperatures at the Cortena station during this period ranged from 36 to 94 degrees (Fahrenheit).

The direct combining of rice, when practiced in conjunction with a drier operated under suitable temperature conditions, appears to be one good method of eliminating or reducing some of the bad effects of weather on the milling quality of rough rice. To combine rice before it has become seriously checked usually means that it must be harvested with a comparatively high moisture content, and then it must be dried or cured under controlled conditions to put it into safe condition for permanent storage and for the improvement of its milling quality.

Investigations over a period of three harvest seasons made by the Grain and Rice Investigations Office of the U.S.D.A. Bureau of Agricultural Economics show that California Japan Rough rice of even very high moisture content can be dried successfully with mechanical driers if the proper procedure is followed in the drying operation. The methods used in drying rough rice differ somewhat from those used in drying other grains, primarily in that lower temperatures and rates of drying are utilized, and the rice is given a series of successive dryings between which there are periods of rest in which the moisture in the kernels becomes more equalized.

A type of drier that has been used successfully in California for drying rice is shown in the accompanying illustration. The drier is composed of three units all of which are practically alike. Each unit serves as one stage of a complete drying operation, and consists essentially of two vertical walls of screened-in rice placed parallel to each other and about 10 inches apart. The enclosed space between sides of the two walls of rice is used as an air duct through which the air used in the drying process is conducted under a slight pressure to force it through the adjacent walls of screened-in rice. After passing through the rice the air emerges from the opposite side of each wall of rice to the atmosphere. The rate of feed or drying of the rice is controlled by means of a cone-pulley drive. The volume and temperature of the air used in drying when heated air is used, are controlled by valves which permit greater or smaller quantities of cold natural air to pass into the air ducts leading to the drying units.

The owner of the drier restricts the maximum temperature used in the drying operations to 90 degrees (Fahrenheit). This temperature is based on the owner's experience in the rice industries in Italy. At this low temperature the drying is slow. It has been estimated that



[1]Paper presented at a meeting of the Power and Machinery Division of the American Society of Agricultural Engineers, at Chicago, December 1931.

[2]Associate marketing specialist, grain and rice investigations office, Bureau of Agricultural Economics, U. S. Department of Agriculture, San Francisco, California.

[3]Tests by Stirniman and Dunshee, University of California, in cooperation with the Grain and Rice Investigations Office, U.S.D.A. Bureau of Agricultural Economics.

about five hours are required for the rice to pass through the three drying units of the drier to accomplish a reduction in moisture content from 23 to 15 per cent.

In the mechanical drying of rough rice it appears that the principal conditions to guard against are high temperatures and too rapid rates of drying. Comparatively low temperatures and low rates of drying appear to be the best for drying rice to preserve its milling quality. Such attempts to dry rice in California as have been unsuccessful can be traced usually to the use of high air temperatures or to too rapid rates of drying. Temperatures of about 170 degrees used in drying wet California Japan Rough rice in the 1927 season resulted generally in low yields of whole kernels, some lots yielding as little as 33 per cent of whole kernels, or "head rice."

Exceptional milling results, however, have been obtained from rice harvested in a damp condition by the direct combine method and dried with natural or heated air at temperatures of 90 degrees and less.

During the 1927 drying operations the temperature and humidity of the air used for drying the rice averaged 82 degrees, ranging from 77 to 92 degrees, while the humidity of the air averaged 33 per cent, ranging from 23 to 44 per cent.

During the 1929 drying operations, when unheated natural air was used to a larger extent for drying the rice, the natural air temperatures ranged fom 51 to 89 degrees with humidities ranging from 26 to 94 per cent. During these operations natural unheated air was used only during periods of low humidity usually occurring when temperatures were highest. Heated air was used in the early morning and late evening hours, when the natural air temperatures were normally low and the humidities high. However, on cloudy and cool days it was found necessary to use heated air during all hours of the day to get satisfactory drying conditions.

Records show that the temperature of the air actually passing through the rice this season ranged from 76 to 94 degrees.

One lot of California Japan Rough rice of the Onsen variety dried in this manner gave an actual milling yield of 70 per cent of fancy head rice and a total milled rice yield of 75.4 per cent. It is probable that very few lots of rice that were cured in the field would give such high milling yields.

Mixtures of combine harvested rice with binder-cut rice that was not allowed to cure in the fields much more than a day were also dried at these low temperatures. Such lots gave milling yields of fancy head rice ranging from 62.5 to 66.5 per cent, and total yields of milled rice ranging from 71.8 to 73.6 per cent. The high milling results quoted are good evidence that California Japan Rough rice can be dried with low air temperatures greatly to the advantage of the milling quality of the rice.

It will be interesting to note with reference to the above yields that rices harvested during this season by the binder or windrow systems and allowed to cure under field conditions, yielded in the neighborhood of 55 per cent of head rice which is considered of good milling quality. Some lots of such rice may yield as high as 60 per cent of head rice, although these are considered exceptions rather than the rule.

The drying of rice with unheated air is simply a matter of the unheated air being naturally of approximately the heat desired for rough rice.

Research Problems in Artificial Drying of Forage Crops[1]

By W. M. Hurst[2]

THE PROBLEMS involved in artificial drying of forage crops fall in at least three major fields of agricultural research—agronomy, engineering, and animal industry. No research program dealing with the subject as a whole will be complete unless these phases are studied.

A forage drier of sufficient capacity for farm use is a rather expensive machine. In order that overhead expenses may be reduced to a minimum, it is necessary to find use for the drier during a considerable period each season. Cropping systems should be worked out which will meet such requirements in different localities. Studies should also be made pertaining to the proper time of harvesting, in order to obtain the maximum yield per acre, not only in pounds of feed but also in nutrient value. With an artificial drier available it may be possible in some cases to extend the area in which a particular crop is grown, or to introduce new crops which might be specially profitable if artificially dried.

Equipment and methods must be worked out to reduce the labor involved in harvesting and getting the green material to the drier. It is also essential that the efficiency of driers be increased, and that equipment be developed for rendering the dried product convenient for handling in shipping and feeding. It seems possible that the efficiency of driers may be increased by crushing and chopping the material before it is fed to the drier. It may be economical to pass the material through the drier several times, allowing sufficient time between the drying operations for equalization of the moisture in the material. In this way extraction of the moisture would occur more uniformly through the stalks and stems, whereby there would be less tendency toward "case hardening" of the outer layers of fiber which retards evaporation of the moisture from the inner fibers. It may be advisable to wilt the material in the field before it is hauled to the drier, to reduce the quantity of water which must be evaporated and the weight of the material to be hauled.

The maximum drying air temperature that can be used without injury to the product, and the proper period of exposure for different types of driers, should be determined. It is essential that the engineer, the agronomist, and the animal husbandryman cooperate in this study in order to determine the effect of different treatments on the quality of the product as indicated by chemical analyses and feeding trials. Comparable samples of forage grown in a particular field and cured under natural conditions should be obtained for comparison with samples of the same material from the drier. Comparable lots of forage must also be selected for feeding trials, on a scale large enough to give conclusive results.

Forage is a product of relatively low market value, in comparison with other agricultural products which are dried artificially. It is bulky, and has a high moisture content when cut. Unless such feed can be produced at a lower cost with an artificial drier than it can be produced by natural drying, or unless a product of much superior quality can be obtained, there seems to be but a limited field for artificial drying.

[1]Paper presented at a meeting of the Power and Machinery Division of the American Society of Agricultural Engineers, at Chicago, December 1931.

[2]Associate agricultural engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture. Mem. A.S.A.E.

The Production and Use of Galvanized Roofing Sheets

By G. C. Bartells[1] and K.J.T. Ekblaw[2]

GALVANIZED SHEETS are and have been for many, many years widely used in building construction both for rural and industrial purposes. No exact data are available covering the total tonnage of galvanized sheets used in the rural field, but the figures run well into the hundreds of thousands of tons annually. As a matter of fact, galvanized sheets,—or "galvanized iron," to apply a term common in former days,—constitute one of the most popular building materials used for farm buildings, grain elevators, warehouses, and other similar structures.

The reason for this popularity is not hard to find. Galvanized sheets are produced in quantities at a number of important distributing centers, consequently their rural distribution is almost universal. Due to low cost of raw material and quantity production the cost to the consumer has always been low. Galvanized sheets are fireproof and when properly grounded afford excellent protection against lightning. Also, heavily coated galvanized sheets have proved exceedingly durable, rendering a service which has satisfactorily met the demands of the user. Their application to farm buildings is a comparatively simple matter requiring no skilled or expensive labor.

A brief summary of the process involved in the production of galvanized sheets may be of interest not only to the general reader but to the architect or engineer who has to do with their application.

A galvanized sheet is a sheet of base-metal coated with zinc to protect it against rust. Any one of the several kinds of steel or iron commonly used may constitute the base-metal, among these being Bessemer, open-hearth and copper-bearing steels, pure iron, copper-bearing iron, and wrought iron.

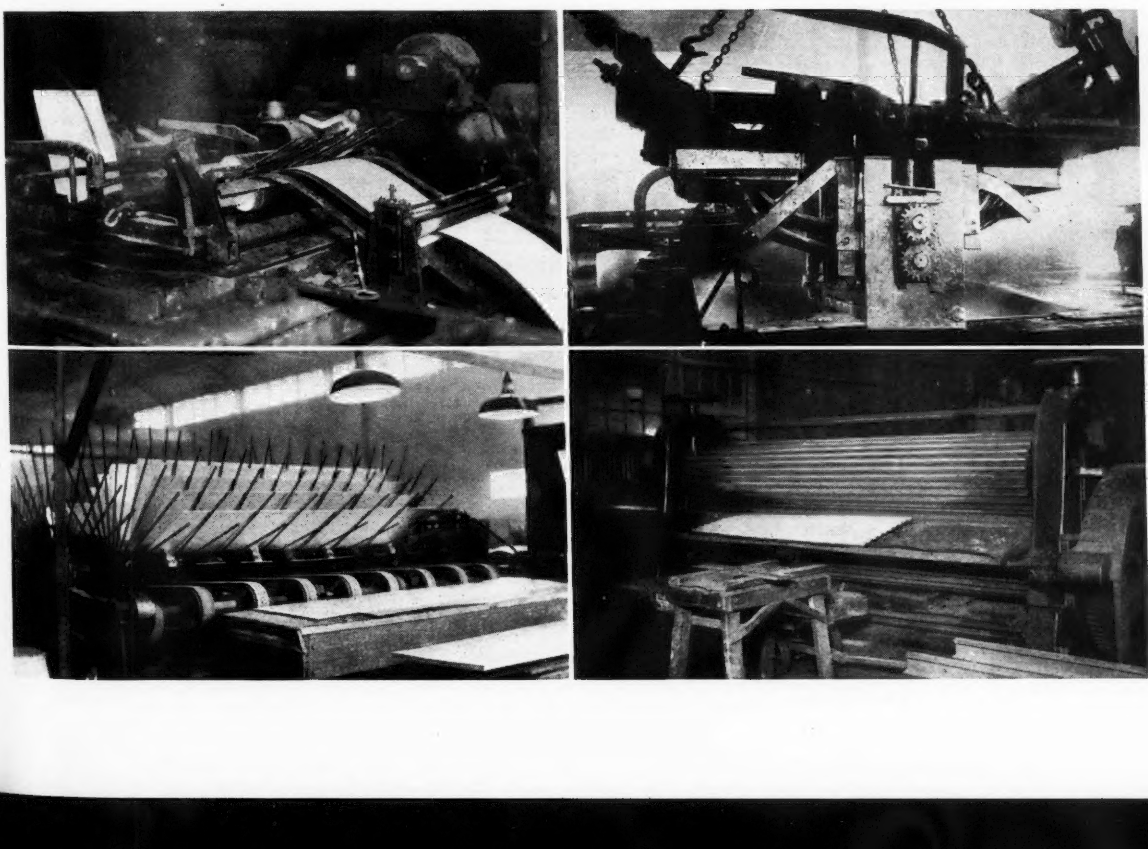
[1]Field representative, American Zinc Institute. Mem. A.S.A.E.
[2]Agricultural engineer, American Zinc Institute. Mem. A.S.A.E.

The steel or iron used for the base-metal is first rolled into sheets of the proper thickness, according to the purpose for which the sheets are to be used. The thickness or weight of the sheet is measured in terms of gage numbers; the lower the gage number, the heavier the sheet. For rural buildings galvanized sheets of No. 28 gage or heavier should be used, to obtain the requisite strength and stiffness.

The Galvanizing Process. The process of galvanizing may be roughly outlined in the following steps, beginning with the "black" sheets (the base-metal sheets as they are delivered, trimmed to size, at the galvanizing department):

1. Annealing
2. Pickling
3. Washing and preparing for zinc bath
4. Coating in the zinc bath
5. Cooling, inspection, and sampling
6. Disposal of finished sheets

1. Strictly speaking, the annealing of the black sheets does not come under the jurisdiction of the galvanizing department; but inasmuch as this is one of the essential



(Upper left) The uncoated sheet emerges from the hydrochloric acid bath at the right, and is guided through the gutta-percha covered preliminary rolls, down into the molten zinc and through the bottom rolls, and last through the exit rolls. (Upper right) This huge frame carrying the three sets of rolls is submerged in forty tons of molten zinc when operating; the depth of submergence is clearly indicated by the zinc adhering to the frame. (Lower left) The coated sheets are cooled while being carried around on the "quills" of this "porcupine rack" and then deposited on the inspection table. (Lower right) After being galvanized the flat sheets are passed sidewise through huge rolls with meshing corrugations which put corresponding corrugations into the sheets

processes preliminary to galvanizing, it is mentioned here. The annealing is done by heating the sheets in large "box-ovens," in order to give them the proper temper and workability. During the rolling process and the subsequent annealing a layer of oxide is formed on the surface of the sheets; the distribution of the oxide may be quite variable, and care must be used in the pickling process to see that it is properly removed.

2. The purpose of the pickling operation, which is the submersion and agitation of the sheets in a hot dilute sulphuric acid bath, is to remove the oxide scale and leave the surface of the sheets perfectly clean, in a slightly etched condition that will promote a ready and uniform attachment of zinc.

Considerable skill and judgment are required in this process to insure that the sheets are not "over-pickled." Over-pickling results, first, in a waste of metal and acid; second, in a surface that is etched to an unnecessary depth, and, third, in a deposit of carbon from the steel, forming a film on the surface which interferes with the later coating with zinc.

3. Washing the pickled sheets is necessary to remove the iron salts formed during the pickling operation as well as any traces of sulphuric acid that may remain on the sheets. The complete removal of acid is accomplished by the use of an alkaline wash such as sal soda, soda ash, or lime. Sheets thus washed are generally stored in water until they are ready to be galvanized. Just previous to passing through the zinc bath they are given a final treatment in a dilute hydrochloric acid bath, to remove any further traces of iron salts that may have formed through oxidation.

4. The next step is the actual coating of the sheets with zinc. This is done by forcing the sheets through a bath of molten zinc, contained in a large iron kettle or "pot" holding about forty tons of zinc. On top of the molten zinc is a layer of sal ammoniac flux, which serves the double purpose of fluxing the uncoated sheets before they enter the bath and preventing oxidation of the molten zinc exposed to the air. The flux is lighter than the zinc and is confined to the area in which the sheets enter the zinc bath by means of a bottomless iron flux box, the sides of which extend below the surface of the molten zinc.

The galvanizing machine is partly immersed in the zinc and is equipped with three sets of steel rolls which carry the sheets along; these are termed the "entrance," "bottom" and "exit" rolls. The sheets are first lifted out of the hydrochloric acid bath and fed into a preliminary set of rolls, covered with gutta-percha or cloth, which squeeze the surplus liquid off the sheets before they enter the zinc bath. After passing through the entrance rolls, the sheets are guided by metal fingers down through the flux box into the zinc pot and between the bottom rolls. Emerging from the zinc bath they are gripped by the exit rolls, the surfaces of which are cut with shallow spiral grooves which serve to distribute the zinc adhering to the sheets.

The weight or thickness of the zinc coating adhering to the sheets is governed by several factors, among which are the height of the zinc in the pot with regard to the "nip" of the exit rolls, the size of the spiral groove on these rolls, the speed of the rolls, the temperature of the zinc bath, and the period of submergence, or the time taken to pass each sheet through the bath. All these factors are more or less adjustable, consequently the weight of coating can be regulated within close limits.

The temperature of the zinc in the pot is maintained by firing with oil, coal, coke, or gas, natural or artificial. The choice of fuel is largely governed by the convenience of these materials with respect to the location and operation of the plant. The operating temperature in the zinc pot is usually between 800 and 850 degrees (Fahrenheit). This temperature is sufficient to cause an alloy to be formed between the zinc and the base-metal at the sheet surface where the two come in contact, resulting in an actual chemical union of the zinc and the base-metal.

Of the ordinary non-ferrous metals zinc is the only one of which this is true at reasonable temperatures. Also, zinc being, in the electrochemical series, negative to iron, it gives an electrolytic protection to the iron or steel even though there be a small exposed area on the base sheet. It is for these reasons that zinc is stated by the U. S. Bureau of Standards in its circular No. 80 to be "by far the best" protective metallic coating for the rust-proofing of iron and steel.

5. After leaving the exit rolls the coated sheets are carried to the cooling rack by a conveyor chain. The zinc coating upon the sheets cools and crystallizes very rapidly and gives the surface a characteristic "spangled" appearance.

From the conveyor chain the sheets are passed onto a "porcupine" cooling rack, a large rack with radial fingers which turns slowly and allows the sheets to cool off considerably. From the cooling rack the sheets are taken off onto a well-lighted inspection table where possible defects are looked for. Sheets possessing any defects or imperfections are either rejected and sold as "seconds," or rerun to remove these defects.

The inspection of the sheets includes the testing for weight of zinc coating. This may be done either by the spot test, in which samples are taken from different points on the area of the sheet and analyzed for weight of coating, or by the "shop-weight" method, in which the sheet is weighed before and after coating, the difference in weight being a measure of the coating. The thoroughness with which sampling is done depends upon the specifications under which the galvanized sheets are being made.

The weight of coating is expressed in ounces per square foot of flat sheet, meaning that approximately one-half the weight is on each side of the sheet.

6. Since the sheets are trimmed to size while in the "black" or uncoated stage it follows that in the disposal of the galvanized sheets all that is necessary is to mark them with the necessary identifying brands, trademarks, etc., package them properly and see to their shipment. On certain types of sheets such as are required for special industrial work, export trade, culverts and so forth, special marks must be placed.

Under the present system of distribution it is often difficult for the producer to know to what use the sheets are to be put, whether for flat work, for corrugating, or other special forming operations. Formed roofing sheets of one or more types are produced at all of the galvanizing plants and distributed through jobbers and dealers. In addition large tonnages of flat sheets are sold to fabricating plants located all over the country, where they are made up into various types of roofing and other products. From these fabricators the sheets are also distributed to the retail trade.

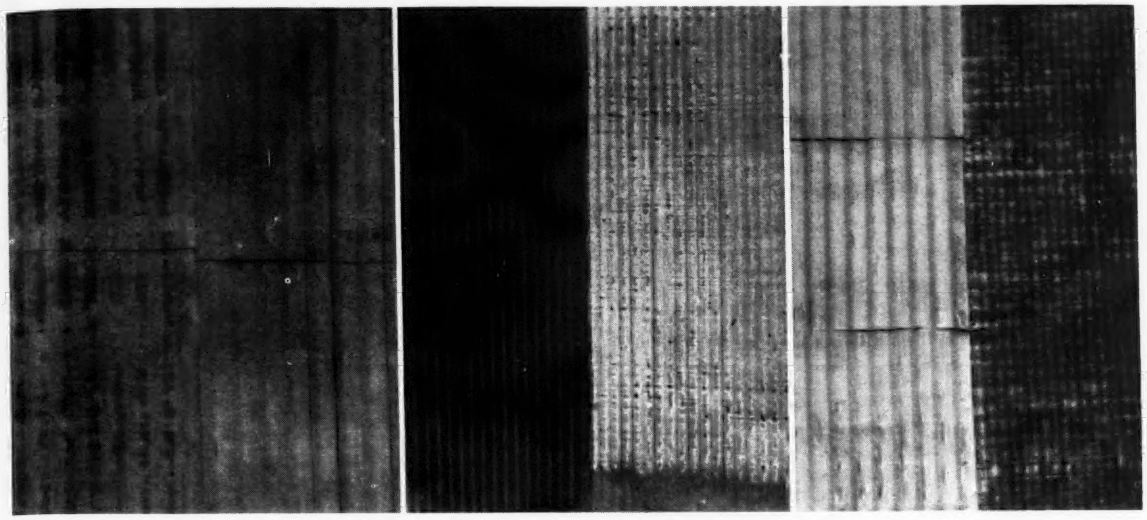
Types of Roofing and Siding. Galvanized roofing sheets are produced in corrugated, crimped, and specially stamped styles. The following, taken from a manufacturer's catalog, will indicate some of the various styles of roofing and siding: 2½-inch corrugated, 1¼-inch corrugated, ⅝-inch corrugated, 2 V-crimped, 3 V-crimped, 5 V-crimped, pressed standing seam, weather-board siding, plain brick siding, rock face siding, self-capping roll roofing, double-standing seam roll roofing, formed ridge roll, elevator siding.

The most popular types of galvanized roofing are as follows:

Corrugated roofing is made from flat sheets which have been formed into a series of alternate ridges and grooves by passing them between rolls of large diameter. The rolls are so formed that, when they mesh into each other as the sheets pass between them, the corrugations are produced. These corrugations give the sheets added rigidity and strength and afford a better surface for the water to run off. The commonest widths of corrugation, measured from ridge to ridge, are 2½ and 1¼ inches.

V-crimped roofing is made from flat sheets by forming on each sheet two or more rather sharply bent ridges that resemble an inverted letter "V". These are made either in the roll type of machine as used for corrugating or in a toggle press.

2V-crimped roofing has one such ridge at each edge of the sheet.



(Left) The clean sheet has been exposed to the elements since 1913, but its 1.6-ounce coating has prevented rust from appearing. The mottled, rusty sheet with only 0.84-ounce coating, had this appearance after only nine-years' use. (Middle) These sample sheets were taken from a central Illinois barn. The dark, rusty sheet, originally coated with 0.82-ounce zinc per square foot, looked like this after 8-years' exposure, while the 1.73-ounce coated sheet showed only very slight discoloration after 15-years' service under similar conditions. (Right) Two Missouri barns about a mile apart furnished these sample sheets. The clean sheets, with 2.8-ounces of zinc per square foot, have given 35-years' service with scarcely any visible deterioration, while the light 1.2-ounce coating originally on the rusty sheets has largely disappeared after 10-years' service

3V-crimped roofing has these and an additional ridge in the center.

5V-crimped roofing has two ridges at each edge and one in the center.

Pressed standing seam roofing is somewhat similar to the 2V-crimped roofing except that the sides of the ridges are squeezed together practically vertical. This type of roofing is sometimes used on roofs of low pitch since the higher seam forms an additional protection against seeping water from rain or snow.

Special drain types of roofing are a modification of the V-crimped type, and are made and sold under various trade names.

Roll roofing is simply a series of flat sheets with their ends locked together into one roll 50 feet or 100 feet long. These sheets are used in roofing work where the flanging is done on the job.

Metal shingles and tile of various sizes and forms are used to a considerable extent especially for residences.

Application of Galvanized Sheets. While galvanized sheets are used for many purposes in the agricultural field a large proportion find application as roofing and siding, and we shall therefore emphasize this use in this paper.

The average man accustomed to doing much of the simpler construction and repair work on farm buildings will have no difficulty in applying the ordinary types of galvanized roofing, especially on buildings of simple design. About the only tools needed are a hammer and a pair of heavy tinner's snips, the latter for cutting the sheets when necessary.

When a building is to be reroofed the old roof covering may be left on, and the galvanized sheets laid over it. However, much better results can be obtained if the old roofing material is removed and the sheathing securely nailed down. Through this means, also, the nailing of the sheets can be more effectively done as the nailing strips are visible.

The pitch of the roof should be considered in selecting the type of galvanized roofing for any particular building. The manufacturer's recommendations, given in their research pamphlets, are not to use anything but double-standing seam on roofs with a pitch of less than 2 inches to the foot. V-crimped roofing is not recommended on a pitch of less than 2½ inches to the foot, nor corrugated roofing on a pitch of less than 3 inches to the foot. Inasmuch as farm buildings seldom have roofs with a pitch of less than 3 inches to the foot, corrugated roofing can be used in the great majority of cases.

Certain practical considerations enter into the application of galvanized roofing, which the architect or engineer should understand in order successfully to supervise its installation.

A good base upon which to apply galvanized roofing is most important. It should be strong enough to support the sheet without sagging and distortion. Galvanized sheet roofs are lighter than shingled roofs, but since the chief load on a roof comes from snow, ice and wind pressure, it follows that the usual substantial roof training is necessary.

Most galvanized corrugated sheets are 26 inches wide, but because the edges are lapped when the sheets are put on, each sheet covers a width of 24 inches. The rafters should therefore be 24 inches apart, center to center, to correspond with the side laps of the sheets.

When nailing strips are used, a secure hold for the nails can be obtained with 1x6 hardwood boards, or 2x4 softwood planks, either one spaced from 18 to 24 inches apart for No. 28 gage sheets and 24 to 36 inches apart for No. 26 gage sheets. On the top edge of the rafters, between the nailing strips, pieces of wood 1x2 or 2x2 should be placed, to afford a continuous nailing surface for the side laps.

In place of the nailing strips, 2x4 headers can be set in between the rafters at the intervals stated above. These can be staggered slightly so as to provide easy nailing at the end. Such an arrangement naturally provides an even nailing surface, allowing the sheets to come flush with the rafters.

Since galvanized sheets are laid with side laps, it is advisable to start laying the sheets at the end of the roof opposite the direction of prevailing winds. For example, where the roof ridge extends north and south and the prevailing winds are from a northerly direction, the sheets should be laid first at the southern end of the roof; thus the overlapping is in the direction with the wind and the possibility of heavy winds driving rain and snow under the lap is reduced.

Corrugated sheets should be applied one course at a time from gable to gable; the eave course is laid first. Other types of roofing are laid one row at a time starting at the eave and working to the ridge.

Good construction in applying all types of galvanized roofing sheets except corrugated demands that the material be bent down over the edges of the roof at gable and eaves so as to protect the wood deck from the weather. In applying corrugated roofing the gable end edges are bent down, but the eave-drip edges are permitted to overhang about 3 inches. On gable ends better results can usually be had by bending the sheets before nailing to the roof.

The width of the side lap depends on the character of the roofing; 2½-inch corrugated roofing is usually lapped one corrugation; 1¼-inch corrugated roofing is usually lapped one and one-half corrugations. The end lap should be about 6 inches, to afford adequate protection against the weather.

The choice of nails for fastening galvanized sheets to the roof structure is extremely important, for the life of any roofing material is no longer than that of the nails with which it is fastened. Whatever type of nails are used should be heavily coated with zinc. They may be fitted with a lead head, a lead washer, or a soft iron mushroom cap, any one of which will seal the nail hole and prevent leakage and rusting of the sheet at that point.

Separate end flashing should be used at the top of lean-to roofs where the roof adjoins a vertical wall. Likewise, side-wall flashing should be used where the sides of roofs adjoin vertical walls. The top edges of the flat portions should be fastened to the wall with short galvanized roofing nails spaced about two inches.

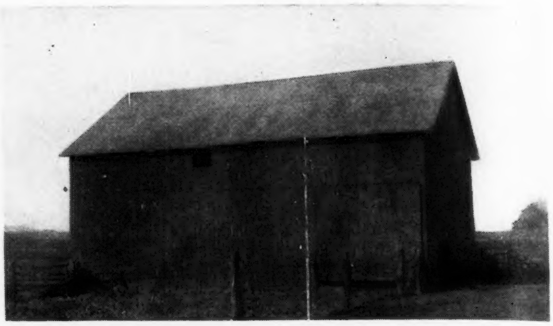
For finishing the peak of a roof, the use of galvanized ridge roll, which can be obtained in a variety of forms, is recommended. Special galvanized forms are also made for use at the break in gambrel roofs. They fit under the top sheet and over the lower one, and when properly applied they prevent leakage at the break. On Gothic-arched roofs of gentle curvature, it is possible to bend corrugated sheets to fit, but for more sharply curved roofs, it is best to use the curved sheets which are made for this purpose, and are obtainable at a small extra charge.

Grounding of Galvanized Roofs. Galvanized roofs when properly grounded provide excellent lightning protection. It is necessary only to install approved conductors such as galvanized stranded cable or galvanized pipe, one at each of two diagonal corners of average size rectangular buildings, or on long buildings at intervals of not to exceed 100 feet around the building. In the case of wings or ells one ground should be put at the outside corner of each such extension. The conductor should be fastened to the roofing metal by means of tightly bolted or riveted joints. It should be attached directly to the building with secure fastenings which will hold it at least two inches from the wall, and the lower end should be buried in the earth to the level of permanent moisture.

Galvanized Siding. The suggestions given for the application of galvanized sheets to the roofs of buildings apply with equal pertinence to the side walls. Galvanized sheets can be readily applied on the old boards either vertically or horizontally, or on new construction they can be nailed either to the siding boards or direct to the studding. The galvanized sheet siding should not come in contact with the soil at the bottom of the walls, but should be fastened to a broad base-board at the lower edge.

Durability of Galvanized Sheets. While there are several factors which influence the service life of galvanized sheets, a recent survey by engineers of the American Zinc Institute, involving examination of hundreds of farm buildings roofed with galvanized sheets, indicates quite conclusively that one of these factors, namely the thickness or weight of the zinc coating, is of outstanding importance.

From the consumers' standpoint the service life of galvanized roofing is found to mean the length of time after installation before the appearance of rust areas. These rust areas indicate that the base-metal has been exposed so that corrosion can occur. When this happens, unless the roof is painted, not only will rust develop at the exposed points but rust stains will be carried down over the zinc coating itself, to such an extent that the appearance of the building and even its utility may be seriously impaired.



An excellent example of the service given by galvanized sheets with adequately heavy coatings. This barn was roofed in 1906, and the sheets are still in good condition, promising many more years of satisfactory service. The weight of coating was slightly over 2 ounces per square foot

The survey above mentioned covered ten important farming states of the Middle West, and disclosed a great variation in the service life of galvanized sheets. In many cases actual sheets were taken from the roofs, and the weight of the zinc coating was in each case determined by sampling the covered end of the sheet. Examples of these findings are indicated below.

Years in service	Weight of zinc coating (oz per sq ft)	Condition
15	1.7	Very little rust
8	0.8	Very much rust
11	1.9	Very little rust
11	0.9	Very much rust
18	1.6	No rust
9	0.8	Much rust
10	1.9	No rust
10	1.2	Very much rust
20	1.7	No rust
10	1.2	Considerable rust
25	2.2	Very little rust
3	1.1	Much rust

A study of these results indicates that in those cases where the weight of zinc coating was around one ounce per square foot, the service life was comparatively short. On the other hand, when the zinc coating was about 2 ounces per square foot, the service life was much longer, the condition of the roof was good, and little or no rust had appeared. The roofs with heavy coatings gave every indication of giving satisfactory service for a still longer period.

Based on these investigations the American Zinc Institute has adopted a program which will enable the consumer to obtain galvanized sheets of standard quality carrying a sufficient weight of zinc coating to insure long years of service. A coating of 2 ounces of zinc per square foot has been adopted as the standard, and a trademark called the "Zinc Institute Seal of Quality" has been devised and registered, to be used only on galvanized sheets carrying this weight of coating.

Leading manufacturers have agreed to produce these heavy-coated sheets, under license from the Institute, for use in the corrugated and V-crimped styles of galvanized roofing and siding, and to submit the product to rigid tests and inspections by the Institute's representatives to maintain this standard. On every sheet so produced appear both the manufacturer's own trademark or name and the seal-of-quality trademark of the American Zinc Institute. The consumer is thus given a guide by which he can identify galvanized sheets of uniformly high quality, comparable to those which have been found by actual experience to give long and satisfactory service.

Agricultural Engineering Digest

A review of current literature on agricultural engineering by R. W. Trullinger, specialist in agricultural engineering, Office of Experiment Stations, U. S. Department of Agriculture. Requests for copies of publications abstracted should be addressed direct to the publisher.

Service Records of Treated and Untreated Fence Posts, R. M. Wirka (American Wood-Preservers' Association (Chicago) Proceedings, 26 (1930), pp. 237-254).—In a contribution from the U.S.D.A. Forest Products Laboratory, a summary is given of experiments conducted at different agricultural experiment stations and other research institutions.

The conclusion is drawn that the life of fence posts is dependent upon such factors as species, percentage of heartwood and sapwood, size, form, preservative treatment, and soil and climatic conditions. The radial penetration of the preservative usually is a better criterion of the value of the treatment than the absorption.

The life of fence posts made from nondurable species can generally be increased to 20 or more years by giving them a thorough hot and cold bath butt treatment and a light top treatment with coal-tar creosote. Neither the hot bath nor the cold bath treatment with creosote when used alone can be expected to increase the life of posts as much as the combination hot and cold bath treatment.

Crude petroleum, petroleum distillate, and other nontoxic oils should not be used alone but are often suitable for mixing with coal-tar creosote in quantities up to 50 per cent. Posts given a hot bath in petroleum oil or water-gas tar, followed by a cold bath with coal-tar creosote, can be expected to have a long life. Posts given a good treatment with copper sulfate by the Boucherie process will give good service. The results indicate that charring is of little value.

Fire Resistance of Wood Treated with Zinc Chloride and Diammonium Phosphate, G. M. Hunt, T. R. Truax, and C. A. Harrison (American Wood-Preservers' Association (Chicago) Proceedings, 26 (1930), pp. 130-159, figs. 17).—Studies conducted at the U.S.D.A. Forest Products' Laboratory are reported. The results showed that the fire tube method of test affords a very useful method of studying the effect of treatment on fire resistance and gives data that are capable of useful analysis. It was also found that the tendency of wood to support combustion and spread flames can be practically eliminated by proper chemical treatments. Of the chemicals studied, the absorptions required for effective flame proofing are much higher than the absorptions of preservative salts required for decay prevention. Both diammonium phosphate and zinc chloride, if used in sufficient quantity, were very effective in reducing the inflammability of wood, the former being more so. The effect of treatment was found to vary noticeably with different species and densities of wood.

A Laboratory Method for Comparing the Efficiencies of Preservatives for Structural Timber, F. H. Rhodes and F. T. Gardner (American Wood-Preservers' Association (Chicago) Proceedings, 26 (1930), pp. 71-75).—Studies conducted at Cornell University are reported. The results showed that of the three general classes of components of coal-tar creosote oil, the hydrocarbons and the tar acids have much higher fungicidal powers than do the tar bases. The hydrocarbons in coal-tar creosote oil are fully as effective fungicides as are the tar acids of similar distillation ranges.

Within each separate group of compounds, the fungicidal power decreases as the boiling point increases. It was also found that the tar acids wet wood a great deal more readily than do the neutral hydrocarbons and are less volatile from wood.

Bracing Farm Buildings, G. W. Trayer and M. C. Betts (U. S. Department of Agriculture Leaflet 77 (1931), pp. 6, figs. 7).—This is a contribution from the U.S.D.A. Forest Products Laboratory and the Bureau of Agricultural Engineering. It gives practical information on the bracing of farm buildings.

A Study of Washing Machines, E. B. Snyder and M. P. Brunig (Nebraska Station (Lincoln) Research Bulletin 56 (1931), pp. 44, figs. 10).—A study of the performance and constructional features of four types of washing machines, including the dolly, gyrator, cylinder, and vacuum types, is reported. To study the cleansing action of different machines, they were used to wash test specimens of fabric which had been soiled under uniform conditions. The machines were operated under uniform conditions of time, temperature and load, and amount and hardness of water and soap solution. The washed specimens were dried under uniform conditions and tested for whiteness or brightness by a photometric method. The brightness, which was the measure of cleanness of the washed specimens, was determined by comparison with a new, unwashed specimen of the same fabric, assumed to be 100 per cent clean.

The results showed that the maximum brightness of test specimens washed in the cylinder and vacuum machines was highest, and from the dolly machines lowest. The difference in maximum brightness of specimens washed in the cylinder and vacuum machines as compared with those from the gyrators was slight. In general, specimens washed in the gyrator machines reached maximum brightness in less time than in other types.

Each machine appears to have an optimum washing period, which depends upon the character of the dirt used in soiling and is affected by the temperature of the water. Washing clothing longer than the optimum period apparently results in redistributing the dirt over the fabric. Medium temperatures (around 125 degrees) gave the best results. Higher temperatures tended to cook or set the dirt into the meshes of the cloth.

There appears to be an optimum load for each machine. A decreased or increased load did not in general give as satisfactory results as did the optimum load.

To determine the comparative wear on fabric, strips of test material were washed under uniform conditions for the same length of time in the different machines. Samples, uniform in thread count, were cut from the test strips, conditioned as to moisture content, and tested for breaking strength by a Scott tester. The breaking strength of the washed samples was compared wih the breaking strength of samples of the new, unwashed material of the same thread count conditioned in the same way. The results showed that the gyrator machines caused less wear than other types and the dolly machines the most. Differences in wear were of slight significance except for one dolly machine, which produced relatively great wear.

To determine the comparative heat retention of the different machines, they were filled with water at the same temperature and allowed to cool under uniform conditions of room temperature and draft. The temperature of the water was taken at 10-minute intervals for a period of one hour. The machines were kept closed except to insert the thermometer. The results showed little difference in the cooling rate for the different machines. The machine having the highest cooling rate was the cylinder type, with large openings in both outside tub and inside cylinder.

Suggestions for the Improvement of Old Bank Dairy Barns, M. C. Betts and M.A.R. Kelley (U. S. Department of Agriculture Circular 166 (1931), pp. 35, figs. 34).—This circular, prepared by the Bureau of Public Roads (U.S.D.A.) in cooperation with the Bureau of Dairy Industry (U.S.D.A.) the Pennsylvania Experiment Station, and the Philadelphia Interstate Dairy Council, is based on a survey of conditions under which milk is produced in southeastern Pennsylvania.

It was found that many of the old bank dairy barns of the area must be improved in order that they comply with the housing requirements set up by regulatory authorities in large centers of milk consumption. The most serious objection to the old barns is the lack of light, ventilation and cleanliness. Although few of these old barns could be improved at a reasonable cost, it was found that a large proportion of them may be remodeled so as to provide an abundance of clean water, fresh air, exposure to sunlight, protection from heat and cold, ample space for the stock, easily cleaned floors, and equipment to facilitate the care of cows. Considerable practical information is given in this connection.

Agricultural Machinery, J. B. Davidson (New York: John Wiley & Sons; London: Chapman & Hall, 1931, pp. X + 396, figs. 600).—This is a comprehensive handbook dealing with the elements of machine design as they relate to agricultural machinery as well as the development and design of actual machines. It is based largely on the author's long experience at the Iowa Experiment Station. Chapters are included on the relation of agricultural machinery to agricultural progress; the function of machines and some mechanical principles; the elements of machines; materials used in the construction of agricultural machines; the design of agricultural machines; transmission of power; measurement of power; friction and lubrication; tillage; plows; plow operation and adjustment; harrows, rollers, and pulverizers; cultivators; seeding machines; corn and cotton planters; grain-harvesting machines; threshing machines; combined harvesting and threshing machines; cornharvesting machines; mowers; machines for making and handling hay; special machines for growing and processing cotton; special machines for growing potatoes; machines for growing garden and truck crops; special machines for corn; feed-preparing machines; grain cleaning, grading, and separating machines; grain conveying and elevating machines; machines for distributing fertilizer; pumps; spraying and dusting machines; machines for the dairy; vehicles; life, use, and cost of agricultural machines; selection and management of agricultural machines; care and repair of agricultural machines; and the manufacture of agricultural machinery in the United States.

The Physical Science of Flour Milling, E. D. Simon (Liver-

pool: Northern Publishing Co., 1930, pp. 222, figs. 43). — This book deals with the principles of flour milling engineering, with particular reference to the physical science underlying the design of the machinery necessary to clean the wheat berry and split it up into the desired products. Chapters are included on the field for development, separation according to dimensions, separation by air currents, dust collection, conditioning — scientific data, conditioning—the practical problem, tests for mill stocks, bran powder, purification, an analysis of the power required to drive a flour mill (paper read by the author in 1913), and a record of tests of the power consumed by various machines in roller flour mills (paper read by H. Simon in 1887). Several appendixes are included.

I, Influence of Diluting Water on the Biochemical Oxygen Demand. II, Digestion of Sludge from Strawboard Waste, E. F. Eldridge and W. L. Mallmann (Michigan Engineering Experiment Station (East Lansing) Bulletin 39 (1931), pp. 14, figs. 4).—Part I reports a bacteriological and chemical study of diluting waters for biochemical oxygen demand. The results indicate that a synthetic water containing the mineral salts common to natural waters is superior to distilled, bicarbonate, carbonate, and phosphate waters. Both tap water and synthetic water gave much higher biochemical oxygen demand results and bacterial count than the other waters mentioned. A marked lag phase both in biochemical oxygen demand and bacterial activity was found in distilled, carbonate, bicarbonate, and phosphate waters. The biochemical oxygen demand values paralleled the bacterial counts. The two limiting factors were the H-ion concentration and the mineral salt content.

In Part II experiments are reported in which strawboard sludge was mixed with sewage sludge, and the rate of digestion as indicated by gas production was studied. A 1:1 mixture of the two sludges gave the largest volume of gas per unit weight of sludge with the exception of the sample containing sewage sludge alone. The volatile matter decrease was about the same in all mixtures. The rate of gas production was prolonged according to the proportion of straw sludge added. The 1:1 mixture was about optimum from the standpoint of rate of digestion.

Effect of Heating Materials and Appliances on the Rate of Hardening of Rapid-Hardening Portland Cement, N. Davey (**Concrete and Construction Engineers** (Detroit), 26, (1931), No. 6, pp. 359-364, fig. 1).—Studies conducted at the Building Research Station in England are reported, in which it was found that the acceleration produced in the development of strength in rapid-hardening cement concrete in the first few hours by preheating the materials is striking. However, the acceleration is much more marked if the concrete after having been placed in a hot condition can subsequently be kept hot. It was found that samples of different brands of rapid-hardening portland cements, and even separate consignments of the same brand, may vary considerably in quality, and it does not necessarily follow that an acceleration of strength due to mixing at a high temperature will always be realized. It was noted that when mixing at a high temperature considerably more water was required to produce a mix of the same consistency as one mixed at normal temperature. There appeared also to be a marked stiffening of the concrete during mixing.

First Report of the Agricultural Machinery Testing Committee, W. C. D. Dampier-Whetham et al. ([Great Britain] Ministry of Agriculture and Fisheries (London), Agricultural Machinery Testing Committee Report, 1 (1931), pp. [191], pls. 14).—This is the first report of the general work of the committee appointed to conduct individual tests of agricultural machinery in England.

The plan of these tests, as organized by the committee and approved by the Minister of Agriculture and Fisheries, provides for the carrying out of tests at selected institutions under the supervision of the committee, and for the issue of official certificates under the seal of the minister and of more detailed reports by the committee. The object is to furnish accurate information regarding the utility, efficiency, reliability, and working costs of each machine or implement tested. Each machine or implement is tested individually, and the certificate and report relate to that one machine or implement. Provision is made in certain cases for tests of different duration, the object being to cover different seasonal conditions. It appears that tests are conducted on application from manufacturers.

The details of the testing scheme are given, together with information relating to the payment of fees and the like. Appendixes are included relating to regulations governing the testing of agricultural machinery, fees charged for testing, and certificates and reports issued to date. The certificates enumerated deal with internal-combustion engines, spraying machinery, dairy machinery, tractors, refrigeration machinery, and harvesting and threshing machinery.

Predictions of 28-Day Tensile Strength of Sand Mortars from 1-Day Information (Maine Technological Experiment Station (Orono) Bulletin 27 (1931), pp. 42, figs. 2).—This publication summarizes research extending over a period of 10 years and gives in detail the method of approach now in use at the station for predetermination of mortar strength.

The results show that the multiple coefficient of correlation for Maine sands is 0.822 ± 0.021. It has been found that a 24-hour prediction of 28-day tensile strength of sands may be made within an average error of 42 pounds per square inch, provided mechanical analysis data, percentage of mixing water, colorimetric test for organic impurities, and the four chemical constituents, iron, aluminum, calcium, and magnesium, are carefully determined.

Built-Up Wood Columns Conserve Lumber, J. A. Scholten (Engineering News-Record (New York), 107 (1931), No. 9, pp. 333-335, figs. 4).—Tests conducted at the U.S.D.A. Forest Products Laboratory are reported, which indicate that laminated or built-up wood columns composed of lumber of small dimensions can be constructed having more than 75 per cent of the initial strength of solid columns of the same size. Individual columns of some designs were found to reach 90 per cent of that strength. No arrangement of laminations or kind of mechanical fastenings used in laminated columns gave results fully equal to those of solid sticks. Considering only the test results of columns with slenderness ratios of from 12 to 24, the small-sized columns of pieces assembled face to face gave about 33 per cent of the strength of a solid column. Tying the edges together with cover plates of such size as to have the moment of inertia practically equal about both axes increased the strength to about 66 per cent of that of a solid column.

In columns of larger size, the type having plain cover plates and a moment of inertia equal about both axes carried about 80 per cent of the load of a solid column, while columns with a solid core averaged slightly more than 80 per cent. It appears that these values apply only when the wood is well seasoned and the columns are built under engineering supervision. It was found that some of the load sustained by the built-up columns is due to friction. The most efficient columns are those least affected by moisture changes subsequent to assembly.

The two most promising types of built-up column were the solid core boxed with planks and laminations with cover plates.

Hot Cement, N. Davey ([Great Britain] Department of Science and Industrial Research (London) Building Research Bulletin 7 (1930), pp. III + 9, pl. 1, figs. 2).—Experiments on the effect of hot cement, meaning cement which is hot to the touch, are reported. Such cement becomes heated by friction during the process of grinding, and, generally, the finer the grinding the higher will be the temperature of the cement as it leaves the mills. The general conclusion is that the effect of using hot cement under ordinary structural conditions is unimportant.

Influence of Engine Conditions on the Anti-Knock Rating of Motor Fuels, R. Stansfield and F. B. Thole (Engineering [London], 130 (1930), Nos. 3378, pp. 468-470; 3380, pp. 512-514, figs. 7; abstracts in Science Abstracts, Sect. B—Electrical Engineering, 34 (1931), No. 398, pp. 51, 52).—Special investigations are reported with a highly sensitive spirit testing plant fitted with a bouncing pin indicator and a special instrument for determining the correct fuel feed and the antiknock fuel. The tests dealt with the effects of a wide range of variation of jacket temperature, different degrees of inlet air heating, variation of throttle opening, variation of spark plug gap and reach, ignition advance, and changes in humidity.

The test methods are described in detail, and the results presented in tables and graphs. The latter indicate that fuel testing engines of different design will give the best agreement when the inlet air is heated to between 120 and 180 degrees (Fahrenheit) and the jacket temperature is maintained at a little below the inlet air temperature. They also indicate the urgent need for a standard design of fuel testing plant.

Check Dams Control Debris Movements on Mountain Streams, L. M. Winsor (Enginering News-Record (New York), 107 (1931), No. 8, pp. 290, 291, figs. 5).—The results of investigations on the use of check dams and other means for separating debris from mountain streams under flood conditions in order that the water may be used for irrigation, as conducted by the U.S.D.A. Bureau of Public Roads and the Utah Experiment Station, are briefly presented. The control works consist essentially of a gravel barrier constructed across the stream bed at a location such that the stream above the barrier may spread over the area several times the normal width of the channel. This results in retardation of the velocity of the water some distance above the barrier and produces a pond of still water immediately above it. The stream commences to unload its burden at the point where it begins to widen, and by the time it reaches the spillway the heavier debris has been deposited. The water impounded behind the barrier acts as an equalizing reservoir and lowers the peaks of the floods.

Oxy-Acetylene Welding Practice, R. J. Kehl (Chicago: American Technological Society 1931, pp. [5] + 104 + [4], pls. 2, figs. 111).—This is a practical presentation of the modern process of welding, cutting, and lead burning, with special attention given to welding technic for steel, cast iron, aluminum, copper, and brass.

Temperature of Maturing of Concrete with Rapid-Hardening Cement, N. Davey (Concrete and Construction Engineering (Detroit), 26 (1931), No. 5, pp. 311-315, figs. 2).—The results of experiments conducted at the Building Research Station in England are reported. These emphasize the importance of the maturing temperature of concrete test pieces made on the job and of protecting small or thin concrete members from the action of cold when using rapid-hardening Portland cement. A large mass of concrete, on the other hand, will be able by its own internal heat to resist the action of cold.

Materials Handbook, G. S. Brady (New York and London: McGraw-Hill Book Co., 1931, 2. ed., pp. XXIII + 588, figs. 13).—This is the second edition of this handbook. It contains a large amount of information of special interest to engineers.

Experimental Studies on the Production of Insulating Board from Cornstalks, O. R. Sweeney, C. E. Hartford, Jr., R. W. Richardson, and E. R. Whittemore (Iowa Engineering Experiment Station (Ames) Bulletin 102 (1931) pp. 64, figs. 28).—This is a rather detailed report of experiments conducted in cooperation with the U. S. Bureau of Standards on the production of insulating board from cornstalks and other materials. Preliminary small-scale experiments showed that good insulating board can be made from cornstalks by various processes. Semi-commercial studies showed that excellent insulating board can be made from pulp produced by digesting cornstalks in water and from pulp produced by mechanically pulping cornstalks. Various combinations of refining equipment were compared, and it was found that excellent results could be secured by using a rod mill and a Claflin refiner in series.

Studies were also made of sizing, fireproofing and waterproofing, and methods and apparatus for testing the pulp and finished board are described.

Heat Transmission, M. Fishenden and A. F. Dufton ([Great Britain] Department of Science and Industrial Research (London), Building Research, Special Report 11 (1929), pp. VI + 20, figs. 7).—Part 1 of this report discusses heat transmission coefficients for various wall materials, and part 2 gives a mathematical discussion of heat transmission laws.

Treatment and Disposal of Dairy Waste Waters, F. H. McDowall (New Zealand Department of Science and Industrial Research (Wellington) Bulletin 27 (1931), pp. 36, figs. 3).—Technical information is given, for the use of engineers, on the treatment and disposal of dairy waste waters. A list of 18 references to the reports of studies bearing on the subject is included.

Durability of Malayan Timbers, F. W. Foxworthy and H. W. Woolley (Malayan Forest Record (Kuala Lumpur), No. 8 (1930), pp. 60, figs. 22).—Data on tests of the durability of Malayan timbers are presented and discussed, including the effect of treatment. A note on termites, by H. M. Pendlebury, is included.

Photographic Flame Studies in the Gasoline Engine, L. Withrow and T. A. Boyd (Industrial and Engineering Chemistry (Washington, D. C.), 23 (1931), No. 5, pp. 539-547, figs. 17).—This report was presented before the American Chemical Society at its meeting in Indianapolis March 30 to April 3, 1931. An apparatus is described with which, by photographic means, simultaneous flame and pressure studies were made of individual explosions in the gasoline engine. The records obtained show the relation between the rates of flame travel and the resulting rates of pressure rise in knocking and in non-knocking explosions. They indicate that the phenomenon of knock in the gasoline engine, which heretofore has been recognized by its characteristic sound and by the shape of its pressure record, is due to a manifold increase in the rate of inflammation within the latter portion of the charge.

The results also indicate that during the combustion process in the engine there is a relatively narrow combustion zone which moves progressively through the charge, and that, after the burning of the fuel in the combustion zone is over, the products of combustion continue to emit light for some time. The intensity of this afterglow increases as the pressure in the combustion chamber begins to rise rapidly, and during the period of maximum pressure it is most intense in those portions of the products of combustion which were formed in the early part of the explosion before the pressure rose above the compression pressure.

It was found that the extremely high rate of inflammation in that portion of the charge which burns at the instant of knock is apparently due to auto-ignition occurring within it. The violence of the knock is determined by how large a portion of the total charge is involved in the spontaneous inflammation or the amount of it still remaining to be burned at the instant knock occurs.

The very rapid and often substantially instantaneous inflammation that occurs within the portion of the charge which burns at the instant of knock is accompanied simultaneously by a very rapid rise in cylinder pressure. The magnitude of this pressure rise increases along with the intensity of the knock.

The one effect upon combustion of the presence of lead tetraethyl in the gasoline is to prevent the extremely rapid inflammation of the latter portion of the charge and the accompanying pressure rise. Lead tetraethyl has no effect upon the velocity or the character of the flame prior to the time at which knock would have occurred in its absence.

List of Institutes and Research Stations Dealing with Agricultural Engineering, A. Brizi (Liste d'Establissements d'Enseignement et de Recherches s'occupant de Genie Rural. Rome: Institute of International Agriculture, 1930, 2. ed., pp. 121).—A list is given of the addresses of institutes and research stations dealing with agricultural engineering throughout the civilized world and also of institutions giving special instruction in the subject. It contains, in addition to the actual addresses of the various institutions, information as to their special branches of activity, the work accomplished or in progress, and the names of the expert staff with a reference to their special responsibilities. The material is arranged geographically and the principal divisions correspond to the five continents, these being in turn subdivided according to the countries they contain, arranged in alphabetical order of their names in French. Three indexes are appended, namely, a classified schedule of subjects in five languages with references to the main list, an alphabetical table of contents in five languages, and a table giving the names of the members of the staff of the various institutions in alphabetical order.

Supporting Strength of Concrete-Incased Clay Pipe, W. J. Schlick (Iowa Engineering Experiment Station (Ames) Bulletin 93 (1929), pp. 64, figs. 24).—The results of tests with commercial vitrified salt glazed clay pipe are reported. These showed that the safe supporting strength of a concrete-incased clay pipe is only slightly greater than the sum of the individual supporting strengths of the clay pipe and the incasement. The supporting strength of an incased pipe increases as its temperature is lowered and vice versa, and the rate of change is very rapid for temperatures between 30 and 0 degrees (Fahrenheit). The increase in supporting strength is due primarily to the effect of temperature on the strength of concrete and, to a lesser extent, to the greater bond strength which is developed. The action of an incased pipe is very nearly that of two independent but concentric rings.

The average values of the moduli of elasticity for each material in both tension and compression are nearly the same. In general, the modulus of rupture of either material may be taken as from two to two and one-half times the ultimate tensile strength and about one-sixth of the ultimate compressive strength.

Detonation Characteristics of Some Aliphatic Olefin Hydrocarbons, W. G. Lovell, J. M. Campbell, and T. A. Boyd (Industrial and Engineering Chemistry (Washington, D. C.), 23 (1931), No. 5, pp. 555-558, figs. 2).—The results of studies are reported which were presented before the American Chemical Society at its meeting in Indianapolis March 30 to April 3, 1931. In these studies the relative tendencies to knock in an engine were measured for 25 olefin hydrocarbons, using them in admixture with gasoline. The results are expressed on a molecular basis, using the antiknock effect of aniline as the standard of comparison. On this basis very great differences appear among the knocking properties of these compounds, even among isomers, including those in which the structural difference lies only in the position of the double bond.

Definite relationships between molecular structure and tendency to knock were found for these compounds. With the straight chain olefins it was observed that in a homologous series the tendency to knock increased with increasing length of the saturated carbon chain, and in an isomeric series the tendency to knock decreased progressively with centralization of the double bond. The tendency to knock was roughly determined by the length of the longest saturated carbon chain. Branched chain olefins showed a somewhat similar behavior. The tendency to knock decreased upon introduction of a double bond, and the knocking tendency apparently was related not only to the position of the double bond but also to the branched structure of the molecule.

Synthetic Lubricating Oils, F. W. Sullivan, Jr., V. Voorhees, A. W. Neeley and R. V. Shandland (Industrial and Engineering Chemistry (Washington, D. C.), 23 (1931, No. 6, pp. 604-611, figs. 3).—A description is given of a systematic investigation of lubricating oils made by the polymerization of olefins with aluminum chloride. Various pure olefins up to C_{16}, including all of the isomeric C_4 and C_5 monoolefins and certain cyclic olefins, as well as unsaturated distillates from cracking various materials, were investigated. The temperature coefficient of viscosity of the polymers was found to decrease with increasing molecular weight of normal olefins and to increase with increasing branching of the chains for isomers. The extreme range covered corresponded to a viscosity index of from 140 to less than —300.

Commercial process has been developed from the production of oils by this means, the products of which are said to be well suited for uses where constancy of viscosity with varying temperature or high oxidation stability are required.

Book Review

"The American Society of Heating and Ventilating Engineers' Guide." 10th edition (1932) is now available. It includes four major sections, namely, text, manufacturers catalog data, index to modern equipment and membership roll of the society. In the text section are 40 chapters of data on design and installation of heating, ventilating and air conditioning systems, all rewritten and revised since publication of the 1931 edition, and containing about 50 per cent of new subject matter. The catalog data section is coordinated with the text and contains data on sizes, shapes, capacities, dimensions, space requirements and applications of specific materials, equipment items and accessories. Illustrated and indexed. Flexible cover, 9x6x1½ inches, XIV + 873 + 64 pages. American Society of Heating and Ventilating Engineers, 51 Madison Ave., New York City. $5.00.

AGRICULTURAL ENGINEERING

Established 1920

A journal devoted to the advancement of the theory and practice of engineering as applied to agriculture and of the allied arts and sciences. Published monthly by the American Society of Agricultural Engineers, under the direction of the Publications Committee.

PUBLICATIONS COMMITTEE

R. W. Trullinger, chairman

C. O. Reed H. B. Walker

J. A. King W. G. Kaiser

The Society is not responsible for the statements and opinions contained in the papers and discussions published in this journal. They represent the views of the individuals to whom they are credited and are not binding on the Society as a whole.

Contributions of interest and value, especially on new developments in the field of agricultural engineering, are invited for publication in this journal. Its columns are open for discussions on all phases of agricultural engineering. Communications on subjects of timely interest to agricultural engineers, or comments on the contents of this journal or the activities of the Society, are also welcome.

Original articles, papers, discussions, and reports may be reprinted from this publication, provided proper credit is given.

Raymond Olney, Editor

R. A. Palmer, Associate Editor

The Farm Bureau and Agricultural Engineering

WHEN Mr. E. A. O'Neal, president of the American Farm Bureau Federation, addressed the annual meeting of the National Association of Farm Equipment Manufacturers last fall he gave generous credit, both direct and implied, to that industry and to agricultural engineers, for their help to agriculture. To the thanks expressed to him at the time by his audience, we would add our own, while commenting on one of his suggestions.

Particularly interesting to us was his attitude on the relation of research to agriculture, and to the farm equipment industry, expressed as follows:

> And now may I as a representative of your only customer—millions of farmers—bring to you some suggestions of a constructive nature as we farmers see them. As a farmer all my life, I know of the great necessity for scientific research, for study that will find out the facts and put those best facts into practices. The Farm Bureau has had on its program, throughout its history, the strengthening and building of such research work throughout the nation. No better place for this work can be found than the agricultural college and the experiment station. My first suggestion is that you assist us in developing these agricultural and engineering experiment stations in our land grant colleges. Here your equipment should be tried out and tested before you yourselves enter on a program of production and before you offer your product to the American farmer.
>
> Might I criticize just a bit here in frankly saying that there have been too many pieces of equipment sold to American farmers in the past by some of your people before thoroughly developing the facts as to the usefulness and efficiency of the machines? Too many millions of farmers' dollars have been spent on useless machines.
>
> This has not only hurt the American farmer but has necessarily reflected on your industry and such a situation, in as far as it now exists, most certainly should be corrected. Would that you would adopt a new policy, that your salesmen, your representatives, first study the needs of the individual farmer most carefully, think less of the sale of the machine and more of the need of the farmer. If your industry is founded squarely on that policy, it will materially increase its service to agriculture and will most surely be rewarded.
>
> I need not here remind you of the unfortunate overdevelopment that characterized the first introduction of the tractor. You know better than I do that the sale of tractors not adapted to the individual's needs gave that useful instrument a black eye, hurt the industry, wasted hundreds of thousands of farmers' dollars and held back the proper use of the tractor for many years.
>
> There are thousands of farmers who have bought machines who have no business to own them. They were not justified in buying them. The economic results have shown this. Sell, if you please, all of the machinery you can, but sell it on an economic basis. Let research, proving economic value of the machine, be the foundation of the sale. More interest, if you please, in the success of the farmer and less in the sale of the machine.
>
> And that is my first suggestion, that scientific research be the foundation for the sale and distribution of farm equipment.

This is undoubtedly representative of the attitude of the more progressive class of farmers. They want equipment which will prove the best possible means of lowering their cost of production under their particular conditions. We have no all-encompassing plan for meeting the challenge. Some first steps come to mind, however, and we believe that others will become self-evident in their turn.

The farmers, as pointed out, would have the equipment manufacturers give their agricultural engineers more rope; their sales departments, more vision and higher objectives.

The manufacturers, we are certain, would have the farmers show more appreciation, in their buying, for carefully engineered products, as compared to those simply thrown together to sell, by unscrupulous companies which are literally parasites on the real farm equipment industry.

They would both have the colleges and experiment stations, and the U.S. Department of Agriculture, enlarge their work of determining the requirements of farm equipment and of testing the effectiveness with which equipment already available meets those requirements.

To the extent that these three things are done the possibilities of low farm production costs will begin to be realized.

Engineering Experiment Stations

IT SEEMS logical and probable that the next major step in the expansion of public agricultural engineering research will be the development of the engineering experiment stations mentioned in the foregoing quotation from Mr. O'Neal.

In a previous editorial[1] we called attention to the need and advantages of such stations. The McNary Bill, providing federal aid for their establishment and maintenance, is before Congress again. It will probably not be passed until the public has developed a keener appreciation of research as a logical function of government; and of the need and value of increased agricultural engineering research in particular.

Farmers and farm equipment manufacturers, as suggested by Mr. O'Neal, may well join with agricultural engineers in developing understanding of and support for the cause of engineering experimental stations.

More Farm Size Discussion

DISCUSSION of large-scale farming has reached the pages of a recent issue of H. L. Mencken's iconoclastic "American Mercury." The author, one Ronald A. Davidson, keeps well to his one-sided subject in presenting "The Case Against Large-Scale Farming."

Perhaps the points he reviews will serve a useful purpose in disillusioning certain individuals without farm experience as to the get-rich-quick possibilities of farming on a grand scale.

They deal with factors advantageous and disadvantageous to large-scale farming which, aside from that possible value, have been discussed to a point of academic idleness. The most economic sizes of operating units for various combinations of specific conditions are being worked out in actual practice, not in magazine articles. The articles of greatest value in promoting progress toward whatever sizes may be most ideal are those dealing with factors not previously given adequate consideration; reporting technical progress which may influence some of the factors involved; or reporting quantitatively actual experience under a known, specific set of conditions.

[1]"Research and the Stations." AGRICULTURAL ENGINEERING, Vol. 11, No. 12 (December 1930), p. 419.

A.S.A.E. and Related Activities

A.S.A.E. Nominations

NOMINATIONS for the elective offices of the American Society of Agricultural Engineers, for the year beginning with the close of the next annual meeting of the Society at Ohio State University, Columbus, June 20 to 23, 1932, have been reported by the Nominating Committee (E. E. Brackett, chairman; G. W. Kable, and B. D. Moses). Following is the list of candidates placed in nomination by the Committee:

FOR PRESIDENT

Charles Edward Seitz, professor and head of the department of agricultural engineering, Virginia Polytechnic Institute

FOR FIRST VICE-PRESIDENT

Walter W. McLaughlin, chief, irrigation division, Bureau of Agricultural Engineering, U. S. Department of Agriculture

Ivan D. Wood, state extension agent in agricultural engineering, University of Nebraska

FOR SECOND VICE-PRESIDENT

Ray W. Carpenter, professor of agricultural engineering, University of Maryland

Arnold P. Yerkes, editor of "Tractor Farming," International Harvester Company

FOR TREASURER

Raymond Olney (secretary of the Society)

FOR COUNCILOR

Hobart Beresford, professor and head of the department of agricultural engineering, University of Idaho

Arthur W. Farrall, director of research, Douthitt Corporation

FOR NOMINATING COMMITTEE

L. W. Chase, president, Chase Plow Company

L. R. Clausen, president, J. I. Case Company

F. C. Fenton, head, department of agricultural engineering, Kansas State College

J. A. King, publicity director, Mason City Brick & Tile Company

M. R. Lewis, agricultural engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture, and irrigation engineer, Oregon State College

S. H. McCrory, chief, Bureau of Agricultural Engineering, U. S. Department of Agriculture

John Swenehart, manager, agricultural section, Atlas Powder Company.

Pacific Coast Section Elects Officers

HOBART BERESFORD, professor of agricultural engineering at the University of Idaho, is the new chairman of the Pacific Coast Section, A.S.A.E. He was elected at the business meeting session of the Section's tenth annual meeting, held at Sacramento, California, January 22.

As no other nominations were made, the Section elected by unanimous ballot the complete slate of officers named in the report of the Nominating Committee. In addition to Chairman Beresford they are: First vice-chairman, R. L. Perry, assistant professor of agricultural engineering, University of California; second vice-chairman, O. W. Israelsen, irrigation and drainage engineer, Utah Agricultural Experiment Station; third vice-chairman, P. C. McGrew, associate drainage engineer, U.S.D.A.; secretary-treasurer, Walter W. Weir (reelected), associate drainage engineer, University of California; member of executive committee, Max E. Cook, farmstead engineer, California Redwood Association; nominating committee, Roy Bainer, assistant professor of agricultural engineering, University of California; E. N. Bates, senior marketing specialist, U.S.D.A., and R. G. Wadsworth, civil engineer, Oakland, California.

Looking forward to 1934, when it anticipates being host for the twenty-eight annual meeting of A.S.A.E., the Section directed its Executive Committee to select the city to be offered to the Society as the best place to hold that meeting.

To make its own meeting schedule more flexible, the Section repealed one of its by-laws which provided for the holding of four meetings each year. Under the new arrangement the Executive Committee will determine the number of meetings to be held each year, except that one annual meeting will always be held.

The Section expressed appreciation for the presence of out-of-state members and guests, among whom were L. J. Fletcher, president of A.S.A.E., and Dr. E. A. White, director of the Committee on the Relation of Electricity to Agriculture.

Short Course in Present Rural Building Problems

PRESENT rural building problems will be the general subject matter of a new annual short course initiated at the University Farm, St. Paul, Minnesota, February 25 and 26. It is offered as a service to both farmers and builders, and will be held in the agricultural engineering building.

The official announcement of the course points out that the problems of farm homes, housing livestock, storing produce, etc., depend on many factors of changing value. These factors will be discussed by men qualified by both technical and practical training. Most of these men are agricultural engineers. Several agricultural economists and architects also have places on the program.

ASAE members scheduled to assist in putting on the school include William Boss, C. L. Berggren and H. B. White of the division of agricultural engineering, University of Minnesota; D. G. Miller, senior drainage engineer, U.S.D.A.; and C. F. Miller, National Lumber Manufacturers Association.

U. S. Civil Service Issues Warning on Examination Situation

WITH reference to the representations of individuals and organizations who for a consideration offer training to prepare persons to pass examination in the U. S. Civil Service, the Commission recently warned that in most branches no examinations will be announced in the near future. This is due to the fact that in most of its branches it already has large lists of eligibles awaiting appointment to any vacancies which may occur. Following is the greater part of the Commission's statement:

"Those who contemplate subscribing for a correspondence or other coaching course in preparation for an examination for the federal civil service are advised by the United States Civil Service Commission to inform themselves in advance of the probability of the announcement of an examination of the kind for which the course of instruction is supposed to train them.

"The Commission's registers of eligibles for most of the common run of positions are so large that the probability is that in most cases it will not be necessary to announce an examination in the near future.

"The Commission is represented by a local board of civil-service exami-

ners at the post office or customhouse in each city in the United States which has a post office of the first or the second class. There are approximately 5,000 of these local representatives throughout the country. The local representatives are given current information regarding announced examinations and are prepared to answer inquiries regarding them.

"It should be understood that the United States Civil Service Commission has no connection with any so-called civil-service school or institute doing business by correspondence or otherwise. The Commission is in no way responsible for statements made in the advertising or correspondence of schools.

"No school can 'guarantee' appointment in the classified civil service of the United States. Examinations are open and competitive, and certifications for appointment are made in accordance with the provisions of the civil-service rules."

New ASAE Members

Russell H. Anderson, curator of agriculture and forestry, Museum of Science and Industry, Chicago, Ill. (Mail) 2151 Maple Road, Homewood, Ill.

Edgar L. Barger, instructor in agricultural engineering, Kansas State College, Manhattan, Kans.

Alvah H. Frost, technical adviser to Detroit Sales Division, Vacuum Oil Co., Inc., 903 W. Grand Blvd., Detroit, Mich.

Frank H. Hamlin, advertising manager, Papec Machine Co., Shortsville, N. Y.

Wilson T. Ide, engineer, Vacuum Oil Co., Inc., 722-18th St., Des Moines, Ia.

James Simon Jacob, agricultural mechanics instructor, Union High School, Lancaster, Calif.

William S. Lynes, traveling salesman, Mason City Brick & Tile Co., L.B. No. 71, Waverly, Ia.

Joseph MacKie, Milwaukee Athletic Club, Milwaukee, Wis.

Lawrence A. Nicholson, associate editor "The Country Gentleman," Philadelphia, Pa.

Celedonio V. Pereda, constructor of agricultural machinery, "Simplex," Maquinas Agricolas. (Mail) Arroyo 1160, Buenos Aires, South America.

Lenore E. Sater, assistant professor household equipment department, Iowa State College. (Mail) 414 Lynn, Ames, Ia.

Dale E. Springer, Garrison, Kans.

Herbert N. Stapleton, instructor, department of agricultural engineering, Pennsylvania State College, State College, Pa.

Transfer of Grade

Earl D. Anderson, research fellow in agricultural engineering, Iowa State College, Ames, Ia.

B. E. Gaylord, farm building engineer, Weyerhaeuser Forest Products, 1108 Merchants Bank Building, St. Paul, Minn.

Edward D. Gordon, Iberia Livestock Experiment Farm, Jeanerette, La.

J. Dewey Long, assistant professor and assistant agricultural engineer, University of California, Davis, Calif.

Darrell B. Lucas, associate professor, School of Commerce, New York University. (Mail) 412 Valley Road, Upper Montclair, N. J.

Walter H. Redit, junior agricultural engineer, U. S. Department of Agriculture, Bureau of Agricultural Engineering, Washington, D. C.

Joseph W. Simons, lumber utilization designer, Long Bell Lumber Sales Corp., 913 R. A. Long Building, Kansas City, Mo.

Byron T. Virtue, department of agricultural engineering, Iowa State College, Ames, Ia.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the January issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Harvey S. Clapp, farmer, Accotink, Va.

Merle F. Feather, sales representative, Blood-Brothers Machine Co., Allegan, Mich.

A. H. Hemker, rural electrification specialist, General Electric Co., 230 S. Clark St., Chicago, Ill.

Miner J. Markuson, assistant professor of agricultural engineering, Massachusetts State College, Amherst, Mass.

Mario Montemayor, timekeeper, Tela R.R. Co., Honduras, C.A.

Ralph Archibald Ross, rural engineer, Potomac Edison Co., Middletown, Md.

George R. Shier, junior agricultural engineer, U. S. Bureau of Agricultural Engineering, 1110 Electric Bldg., Richmond, Va.

Milburn L. Wilson, head, department of agricultural economics, Montana State College and Agricultural Experiment Station, Bozeman, Mont.

Transfer of Grade

Arthur W. Clyde, associate professor of agricultural engineering, Pennsylvania State College, State College, Pa. (Associate to Member)

Grant N. Denike, assistant superintendent, Dominion Experimental Station, Swift Current, Saskatchewan, Canada. (Junior to Associate)

Edward A. Silver, research engineer, Agricultural Experiment Station, Agricultural Engineering Department, Ohio State University, Columbus, O. (Junior to Associate)

Personals of ASAE Members

J. G. Klemgard is senior author of Washington Agricultural Experiment Station Bulletin No. 255, entitled "Cost of Wheat Production by Power Methods of Farming, 1919-1929." It summarizes his cost records and information on his conditions and methods of operation as a large-scale wheat farmer in the Palouse region for the period named. The division of farm management and agricultural economics, and the School of Business Administration, State College of Washington cooperated in the preparation of this bulletin.

Roger D. Marsden, senior drainage engineer, U.S.D.A. Bureau of Agricultural Engineering, is author of U.S.D.A. Technical Bulletin No. 269, entitled "Economical Use of Large Tile for Land Drainage."

Otto Schnellbach, engineer, department for the supervision of agricultural engineering research, German Department of Agriculture, is author of a bulletin entitled "Landmaschinen in Chile." The text is printed in German.

L. J. Smith, secretary, and **Harry L. Garver**, investigator, Washington Committee on the Relation of Electricity to Agriculture, are authors of "A Progress Report of Investigations" carried on under the committee's jurisdiction for the year 1931.

EMPLOYMENT BULLETIN

An employment service is conducted by the American Society of Agricultural Engineers for the special benefit of its members. Only Society members in good standing are privileged to insert notices in the "Men Available" section of this bulletin, and to apply for positions advertised in the "Positions Open" section. Non-members as well as members, seeking men to fill positions, for which members of the Society would be logical candidates, are privileged to insert notices in the "Positions Open" section and to be referred to persons listed in the "Men Available" section. Notices in both the "Men Available" and "Positions Open" sections will be inserted for one month only and will thereafter be discontinued, unless additional insertions are requested. Copy for notices must be received at the headquarters of the Society not later than the 20th of the month preceding date of issue. The form of notice should be such that the initial words indicate the classification. There is no charge for this service.

Men Available

DESIGNING ENGINEER, with broad experience in the designing of tractors, threshers and combines, also in the supervision of manufacture and design, wishes to make a new connection, preferably with a farm equipment manufacturer, either to build new machinery or to improve present designs. MA-209.

AGRICULTURAL ENGINEER, with bachelor's degree in agricultural engineering (1927) from Kansas State College and master's degree (1928) from Iowa State College, and with five-years' experience in teaching agricultural engineering in state agricultural colleges and two summers experience in U.S.D.A. extension schools for county agents. Available at once for employment. Now employed. Age 30. Married. MA-210.